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THE PASTEUR INSTITUTE IN AUSTRALIA.

AUSTRALIA is the victim of a scourge which, although it does not menace human life, is nevertheless an obstacle, from day to day more alarming, to the prosperity of the country. We refer to the number and voracity of the rabbits. These animals devour the grass designed for the sheep, and there are no means of preventing their ravages. This is ruinous to land owners, who, in certain districts, are giving up the raising of sheep, through the impossibility of feeding them. The Australian rabbit does not, as has been said, attain the size of the dog, but is no larger than our own, yet, how much more destructive! It attacks trees and divests them of their bark. If it wishes to reach a new territory, a river does not arrest it, for it crosses it by swimming. Along with that, a multiplication such that no slaughter, as relentless as it may be, can counterbalance it. From this has arisen the rabbit question, the importance of which can escape no one when we say that the government, after fruitless tentatives at destruction, decided a few years ago (in 1887) to offer a prize of \$125,000 to the inventor of a rapid and sure process.

It will be remembered that, a few years previously, Mr. Pasteur had inaugurated upon fowls the experiments that were to lead him progressively to his other admirable discoveries. Upon inoculating fowls with cholera he found that the disease infallibly killed all those that vaccination had not rendered refractory to the contagion. He then conceived the idea that the same disease, or an analogous one, might be propagated among rabbits. As he said in *Le Temps* of November 28, 1887: "In order to destroy beings that are propagated according to the laws of an appalling progression of life, what can be done by the mineral poisons that have been employed up to the present? The latter kill upon the place on which they are deposited; but, truly, in order to reach living beings, does it not require, if I may dare say so, a poison endowed like them with life, and capable of multiplying itself with surprising fecundity?"

The chicken cholera, as has been demonstrated by experiment, is also peculiar to rabbits. Why would it not be with rabbits as with chickens? It would suffice that a few individuals should eat food contaminated with the microbe that causes the cholera, in order that, through the dejections, the disease might be communicated to the burrows of others, that would propagate it in their turn. We recall this letter merely as a remembrance. Madame Pommery having read it, proposed to Mr. Pasteur that he should make an experiment on a large scale on her property of La Marne, where rabbits, through subterranean galleries, were mining the earth of a close of sixteen acres, without ferrets being able to drive them from the huge heaps of chalk in which they took refuge. Delegated by Mr. Pasteur, I, on the 25th of September, 1887, moistened the lucern served to the rabbits as food for the day with a bouillon of meat in which the microbe of the chicken cholera had been cultivated. Thirty-two rabbits found dead upon the ground the next day permitted of the belief that many others had succumbed in the burrows. The fact is that three days afterward, not one of the thousand or twelve hundred animals was stirring that, according to the laborers, had daily devoured the forage distributed; not one had survived.

These results, with an exposure of the laboratory experiments which they confirmed in so brilliant a manner, were communicated to the agent general of New South Wales, near the English government. Mr. Pasteur, in offering to send two of his laboratory students to Australia, ex-



FIG. 1.—AUSTRALIAN WILD DOG (DINGO).

pressed a desire to be allowed to compete for the prize spoken of above. Having related them elsewhere in detail, we shall not revert to the political events which, on our arrival at Sydney, prevented us from carrying out, or even undertaking, the experiments of demon-

question in nowise diminished the circumstances whence it was the issue. The voracity of the rabbits did not relax, any more than did their reproduction. We have just learned that the government is occupied anew with their existence, that is to say, is preparing a new campaign of extermination against them.

As happens with many human enterprises, our expedition to Australia did not give the results hoped for. It was just that, in the way of compensation, it should procure others for us. How many occasions did we not have to employ, in the most interesting researches, the leisure that the general ill will created for us!

Mr. Abigail, the Minister of Agriculture, alone at Sydney, and for particular reasons, gave a welcome reception to the Pasteur mission.

He tried to conciliate favor with it by getting it to apply its scientific methods to the study of a cattle disease that was becoming ruinous to Australia.

Let us remark that, in this new country, where the importation of the various animal species does not date back beyond a century, it is relatively easy to follow the evolution of diseases. The very length of the voyage prevented of old the landing in Australia of animals that might have been diseased before shipment. In order that the appearance of certain diseases should be materially possible, it has been necessary that the establishment of intermediate stations, in reducing the duration of the voyage, should give a considerable extension to the exchanges.

For example, it was in 1847, only sixteen years after the importation of sheep, that there exhibited itself for the first time, at Leppington, a disease which, from the name of the county, was called the Cumberland disease.

What are the total losses really caused by the Cumberland disease, and often, even now, laid to the charge of poisonous plants, although very erroneously? No one can calculate them with certainty. They are estimated approximately at 200,000 head per annum, and as the disease prevails over only a relatively limited portion of the colony, this proportion is alarming enough. For reasons easy to understand, stockmen do not like to admit their losses. It is not necessary, however, to have been long in contact with them to convince one's self that, in certain regions, from 30 to 35 animals are lost out of 100. This is an enormous proportion when we remember that, in Europe, a mortality of from 10 to 12 per cent. appears large. In Australia, a mortality of 30 per cent. is frequent. Certain squatters sometimes say: "My births do not compensate for my losses through the Cumberland disease." One of them, whom I asked what he meant by expressing himself thus, answered: "For the mortality by anthrax in a property in which I had an interest I may say to you that the deaths amounted, one year with another, to from 30 to 35 per cent., and, in fact, the births did not compensate for the losses." Another squatter informed me that, in the infected sections, the mortality is from 30 to 40 per cent.

There would be many reasons to be noted for one who should desire to explain these figures. The dangerous season for sheep is much longer than it is in Europe. It extends from October to June. On another hand, in these immense closes, of from twenty to forty thousand acres, where the noise caused by the fall of the branch of a tree is sufficient to frighten the animals and make them run from one end of the close to the other, it will be conceived that jading is frequent. Now, it has been established that jading favors the development of infectious diseases.

Finally, and especially, the great mortality is no doubt due to negligence in getting rid of dead animals. If an animal succumbs in France,

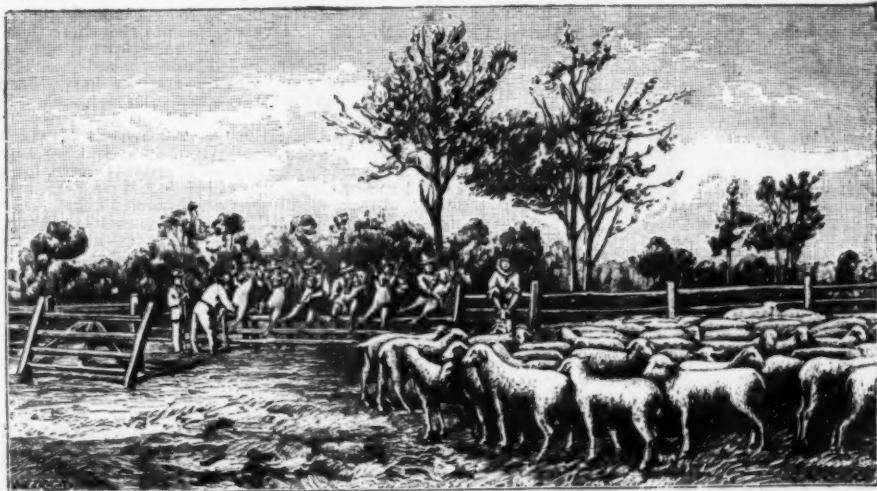


FIG. 2.—VACCINATION OF SHEEP AS PRACTICED IN AUSTRALIA.

stration for which we had come. All our negotiations went for naught. We had to recognize the uselessness of temporization, and, after fifteen months passed in the expectancy of a solution that was eternally adjourned, we had to return to France.

As always happens, retarding the study of the

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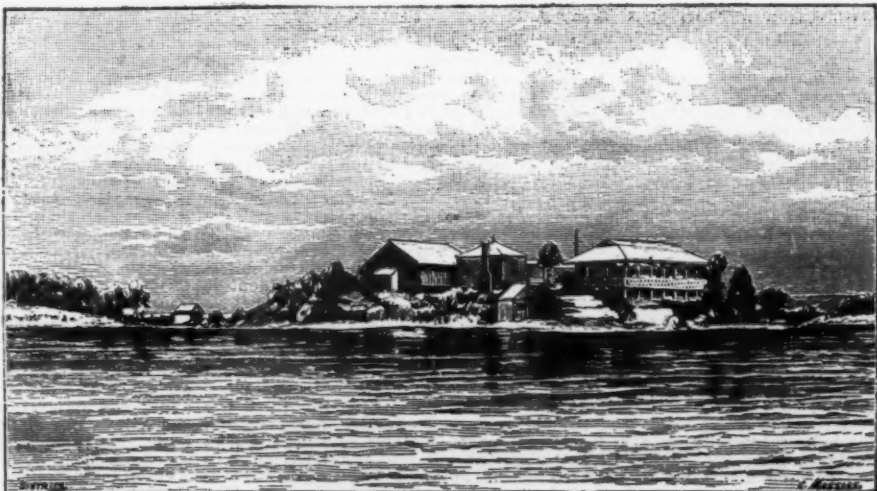


FIG. 3.—PASTEUR INSTITUTE AT SYDNEY, AUSTRALIA.

the hope of a slight remuneration almost always induces some one to carry the carcass to the nearest skinning and cutting up establishment. If the distance is too great, there are true cemeteries for sheep, surrounded by barriers that keep other animals out. In Australia, unfortunately, when an animal dies, it remains *in situ* and is torn to pieces by birds of prey and wild dogs or dingoes (Fig. 1).

There is no exaggeration in saying that in a few years the earth of certain regions is literally saturated with microbes, and the causes of infection are thereby much increased.

As regards incinerating the carcasses, the stockmen are afraid, and not without reason, of thus kindling prairie fires. Why do they not appreciate the danger that their carelessness exposes them to in this regard?

It will be seen from these data how important for Australian sheep breeding would be the discovery of a medication prophylactic against the Cumberland disease.

The Honorable Mr. Abigail asked us to study this disease in order to find out whether or not it presented, as was asserted, the same characters as charbon, and afterward to ascertain whether there would be occasion to apply Mr. Pasteur's discoveries to cattle. It was thus that we were led to make experiments of identification of the charbon and Cumberland disease, and afterward to give a bacteriological proof of the efficacy of charbon vaccine. This demonstration (analogous to that of Mr. Pasteur in 1881, at Pouilly-le-Fort), which appears to partake of the marvelous, was made at Junee.

Thirty-nine sheep and six cows were bought in a district not infected by the disease. Twenty of these sheep and four cows were inoculated on the 4th of September, 1888, with the first vaccine, and, on the 18th, with the second.

On the 30th of September three sheep were inoculated with different quantities of the culture of an animal that died of the Cumberland disease in May. As the period of incubation varied according to the doses, we had a right to foresee that one, at least, of these animals would die on the 2d of October and might thus serve, all fresh, for the virulent inoculations that were to be made on this date in the presence of the Minister of Agriculture, of delegates from the different colonies, and of about two hundred stockmen. At half past three o'clock, on the 2d of October, one of the animals inoculated on the 30th of September died as was expected. After an autopsy and an examination of the blood under the microscope, the commission having assured itself that the death was really due to the Cumberland disease, the inoculation of the thirty-nine sheep was begun (Fig. 2) with the blood of the animal that had just succumbed, one vaccinated and one non-vaccinated animal being inoculated alternately, the same syringe and the same quantity of blood for each of them (about two drops) being used. The six cows also were inoculated with four drops of the same blood. All the animals, vaccinated and non-vaccinated, were placed in the same inclosure, fed in the same way, and provided with the same water. Moreover, fresh grass was spread upon the ground, and it was upon this that the non-vaccinated animals died, thus contaminating the food of the vaccinated animals and increasing the risk for them of contracting the disease. They remained thus confined and fed in this inclosure during the four days that followed the inoculation. The nineteen non-vaccinated sheep all died, the duration of the incubation in these animals varying between thirty and sixty-three hours.

Of the two non-vaccinated cows, one died at half past ten o'clock on Saturday, October 6. The other, after being very sick, regained its health. Six months ago, all the vaccinated sheep and cows were still in very good health in a station where the admitted losses are from 10 to 12 per cent. How could not one have yielded to evidence so manifest? The commission recognized the efficiency of the Pasteur vaccine for preventing the Cumberland disease, or charbon, and, in its report to the government, added that it recommended the adoption of it.

It was not a vain patronage, for, having returned to France shortly after the Junee experiments, for the reasons that we have stated, we were, a few months afterward, and at the instance of the Australians, sent back by Mr. Pasteur to found an institution at which charbon vaccination might be performed. Having arrived in June, 1890, we obtained from the government a comfortable laboratory, located upon a rocky island situated in the splendid roadstead of Sydney, and it is there, on Rodd Island, at twenty minutes from the city, that we have since then been preparing vaccine (Fig. 3). The stockmen here find small tubes containing the quantity necessary to inoculate a hundred sheep. The best proof that we have to offer in favor of the vaccine is the ever-increasing number of our correspondents. About 350,000 sheep have been inoculated up to the present.

We are, therefore, authorized in saying that upon this point French science, represented by Mr. Pasteur, has gained an indisputable success. Knowing this better than any one else, we believe that we ought to say it, since in this distant country, where the French are very few in number, they would do wrong to rely upon the English, any more than on the Germans, to noise abroad their services, supposing they render any.

In the month of June, 1891, the city of Sydney was in a great flurry. Sarah Bernhardt had kept her promise to come to play in Australia. She was about to arrive. All the preparations were made for a royal reception, speeches and addresses were printed upon vellum. The mayor had his newest robe brushed and his youngest wig curled anew, and letters by hundreds invited all the best society of Sydney to come to the city hall to pay its respects to the queen of the stage. The Minister of Telegraphs, at the head of a numerous committee, went to meet her upon a boat adorned with the French colors, etc.

And yet the fete came near proving a failure. The actress had with her two magnificent dogs, from which she was never separated. She was informed that the law required dogs coming to Australia to be subjected to a quarantine of six months. She refused to submit to it, and spoke of nothing less than turning about and directing her steps to more hospitable shores. The minister gallantly assured her that an exception would be made, and that, in order to avoid a public

misfortune, the law would be only too happy to bow before Chouette and Star.

This was without reckoning on the austerity of the legislators, jealous of protecting the healthfulness of the country. The pledge of the minister was no sooner known than a member of the opposition appealed to the government, and the Minister of Agriculture was led to answer that, by consent of Sarah Bernhardt, Chouette and Star would be confined to my care, Rodd Island being declared a quarantine annex. I need not say what an honor it was for me to lodge the bow-wows of the divine Sarah. I merely wish to show by this anecdote the severity of the measures taken against the importation into Australia of diseases as yet unknown.

According to the quarantine regulations, no animal can be landed without the written authority of the inspector-in-chief of cattle, notified at least twenty-eight hours in advance. The bovine, ovine and suide can come only from England or Iceland. A certificate from a veterinary surgeon must attest their good state of health at the time of shipment; another, signed by the captain, their good state of health during the voyage; and another, delivered by a special inspector, their good state of health on their arrival. If the cattle are contaminated, they are destroyed. If they are found healthy, they are sent by sea to quarantine for a period of observation varying from sixty to ninety days, and which, for dogs in particular, is prolonged, as we have said, to six months.

You may, if you please, consider all these measures as exaggerated; but, thanks to their application, the door has been closed up to the present to two diseases that are disseminated almost everywhere—the glanders and rabies. Mr. Pasteur has been good enough to approve of my assertion that in the present conditions of the voyage to Australia, with the quarantine in force, it is practically and scientifically probable that the country will continue to enjoy its immunity. "Rabies," he writes to me, "is never spontaneous in animals. Dogs may be placed in conditions most contrary to their mode of life, cold, heat and food: none becomes hydrophobic. The period of incubation may be longer or shorter: in certain special cases, it has been from six to seven days only. It is usually two months, but it may be six. Periods of a year and even two years have been given, but without a very certain proof. However this may be, rabies in the issue is always the result of the bite of a mad dog. It would be idle to discuss the question as to whence comes the first animal affected. Science is incapable of solving the question of the origin and the end of things."

Unfortunately, other diseases were imported before the establishment of these quarantines, whose efficiency has just been demonstrated: for example, the Cumberland disease, symptomatic charbon, and the peripneumonia of horned cattle.

In the first part of this article, we told how the Cumberland disease had been identified with charbon, and how the prophylactic virtue of Mr. Pasteur's vaccine had been recognized.

The very success of our experiments naturally led us to examine whether this disease, the effects of which in European animals have been studied by Messrs. Pasteur and Koch, could likewise attack the indigenous animals, such as the Australian bear, or *koola* (Fig. 4), which feeds exclusively upon the leaves of the eucalyptus and lives among its branches, the greater kangaroo (Fig. 5), a herbivore of the size of a five or six months old calf, the rat kangaroo, a small herbivore of the size of a rabbit, and the Australian cat (Fig. 6), a wild carnivorous animal of the same size as the domestic cat.

There is no doubt as to the action of the virus upon these animals, whether it be introduced into their organism subcutaneously or by stomachal ingestion. Our successive inoculations have demonstrated that they are affected by bacterial charbon, and that, consequently, being capable of contracting the disease, they are capable of spreading it. Hence there is no doubt that their existence must retard the day when, thanks to charbon vaccination universally adopted, Australia will be able to consider herself assured against one of the most formidable of her scourges.

Of symptomatic charbon we shall say nothing, because the efforts made by us after we had recognized the existence and characters of the disease gave no result, and because we are on the point of introducing the vaccination discovered by Messrs. Arloing, Cornevin and Thomas, of the Veterinary School of Lyons.

The peripneumonia made its appearance in Australia in 1858. It was introduced into the station of Mr. Boodle, of the Plenty district (Colony of Victoria), by a cow that this breeder had imported from England.

This cow, it is said, had had an attack of the disease some time before its purchase. It had been treated and cured, but it appears certain at present that the cure was incomplete, since a short time after the animal was landed at Melbourne, it had a relapse and died. It contaminated the cattle of this stockman, which, in turn, transmitted the disease to the herds of the vicinity.

The conditions of the breeding of large cattle are such in Australia that the disease spread with fearful rapidity. The sanitary police measures, which in countries where the production is limited and the animals are closely watched succeed in arresting the disease, are absolutely powerless in these deserts, where thousands of horned cattle are left alone, almost without surveillance, in immense parks where they are seen only at a distance from each other (Fig. 7). Then again, the carriage of merchandise was formerly done only by means of yokes of oxen (Fig. 8), which were themselves the vehicles of the epidemic and contagion. Hence the disease very quickly reached the neighboring colonies, and the entire Australian continent is now infected with it.

As long ago as 1851, a Dutch veterinary surgeon, Willems, proposed in Europe to inoculate animals in good health with the virus of peripneumonia in order to confer immunity upon them. In 1862, there appeared in the journals of Sydney and Melbourne a letter from a Mr. Cloete, of Cape Colony, describing the preventive inoculation, of a type of which had first been made in the provinces of Victoria and New South Wales. Up to the present, two hundred stockmen have experienced the benefits of it, and its practical value is as well recognized in Australia as in Europe. The government of New South Wales last year asked the owners of cattle a series of questions: 8,205 declared

themselves favorable to inoculation, and 729 against it. As to the question of obligatory inoculation, 7,050 answered in the affirmative and 1,757 in the negative. Why do these figures represent only about half of the persons interested?

The breeders of Queensland, in order to sell their cattle in the markets of New South Wales and Victoria, are obliged to make them follow the routes laid out specially to this effect. The distance to be covered varies from about 300 to 1,300 miles. The herds travel on an average from 6 to 7 miles per day. Now, during these journeys, which take from two to six months to accomplish, the cattle pass through districts in which the peripneumonia is causing the most ravages. Admitting that they are all right on starting, they contract the disease and communicate it to the young animals that they meet with on the way. It is not rare that out of an expedition of from 1,500 to 2,000 head, a mortality of from 25 to 35 per cent. is found upon their arrival. As soon as the first beast dies, the Willems inoculation is performed; but the greater part of the herd is already within the power of the disease, and the losses that we have just noted are not prevented. What would be necessary would be to have a process for preserving the virus of peripneumonia and the capability of furnishing it to the stockman, if he is unable to procure any of it in his station, at the moment at which he is about to start his animals for a long journey upon infected routes. Since the annual loss caused by this disease is about \$1,300,000 for Queensland alone, the colony that possesses the most horned cattle, the subject would merit being studied.

Mr. Pasteur, during the course of some experiments pursued in 1882, pointed out a process for the preservation of the virus. According to him, it suffices to inoculate a calf, not in the tail, as recommended by Willems, but elsewhere (behind the shoulder, for example). The tissues in the vicinity of the puncture are infiltrated with serosity, which is virulent in its turn, and is easily collected and preserved in a pure state. This virus is just as good as that of the lungs, and there is, therefore, nothing to prevent the use of the tumor induced as a source of vaccine matter.

This process had never been put in practice. Our efforts have tended to demonstrate the scientific and practical value of it. The success of the first experiments were most significant. One example out of a hundred: 2,000 cows were vaccinated. At the last moment, there arrived 19 others that were not vaccinated. These two groups started together and made a journey of 1,300 miles. On their arrival, it was found that the 2,000 vaccinated beasts were in good condition, while out of the 19 non-inoculated ones, 8 had died of peripneumonia.

In order to respond to so manifest a need, we instituted a station analogous to those at which, in France, the vaccine virus of smallpox is kept on hand. A calf is kept continually under the action of inoculations made elsewhere than under the tail, that is to say, in the regions that Bonley calls "the regions forbidden under penalty of death." The virus of the oedema is preserved in sterilized tubes and placed at the disposal of stockmen for use in new inoculations. In 1891, the Rodd Island laboratory furnished 300 tubes, the vaccine matter of which, used on its reception, in the manner that we have indicated, has permitted every breeder to have, for the journey of his herds through infected districts, a supply sufficient for three or four thousand beasts.

The number of our correspondents is continually increasing, and, according to what they say of the results obtained, either through the vaccine virus of charbon or that of peripneumonia, it cannot be doubted that the conquest of Australia by microbiology is now an assured fact.—Dr. A. Loir, in *La Nature*.

SAFE AND PERILOUS OCCUPATIONS.

SOME one has facetiously observed that of all occupations that of the assassin is the most conducive to longevity. Certain it is that no sooner is a person known to have committed murder than all the safeguards that human ingenuity can devise are thrown around him, and everything possible is done to prolong his days on earth in comfort, ease, and even luxury. If the vast sums of money, the valuable time, the brilliant talent, the profound learning, the resistless energy, and the nauseating sympathy now wasted on murderers were applied to improve the sanitary condition of our schools, it would be more humane, and the result would be increased health, wisdom, and morality.

There were twenty-nine homicides recorded in this city last year, and the number not recorded probably reached up into the hundreds, for there are many here who live by taking human life, and advertise their bloody trade openly in the newspapers: yet we feel sure that it would be a profitable business venture for any insurance company to issue policies at reduced rates on the lives of this great army of assassins, from the bold and venturesome highwayman to the sneaking and cowardly abortionist.

Among the learned professions, that of pointing the way to heaven keeps its votaries longest on earth, while those who engage in holding others back, or smoothing their path, if go they must, glide swiftly on themselves and soon lose their feeble grip on worldly things; thus, according to English statistics, the death rate among physicians, between 25 and 65 years of age, is more than twice that of clergymen of the same age, lawyers keeping about equally distant in the race for immortality between those who preach and those who practice.

Of course, it is easy to see why medical men die young: irregular habits, loss of food and sleep, exposure to the extremes of weather, jolting and shaking over rough roads, inhaling microbe-laden dust or the foul air of a close carriage, the constant mental strain of weighing diagnostic symptoms and therapeutic indications, with the fear of erring where human lives are at stake, and, last but not least, alas! with many of us, the worry expressly forbidden by the Master according to St. Matthew 6:25-34—all these various agencies speed our journey.

Of manual toilers, those whose occupation keeps them outdoors are, with some few exceptions, the longest lived, the exceptions being due to other causes, as overwork, especially sudden muscular efforts and

strains, liability to accident, and exposure to inhalation of dust and poisonous vapors. Thus, gardeners, farmers, and fishermen are exceptionally long lived, and sailors would be so but for the poor quality of food, insufficient and frequently bad water, and the cramped up, damp, dingy sleeping quarters furnished them. In these respects there has been a great improvement of late years, but much remains yet to be done. Jack's riotous living ashore and too often insufficient clothing at sea are also responsible for many of his ailments. Carpenters and masons, whose work keeps them mostly in cities, where the air is less pure than in the

general election possesses a distinctly medical interest, as practitioners all over the country will shortly have another opportunity of ascertaining for themselves. Apart from the surgical injuries and solutions of cutaneous continuity caused by the impact of brickbats

ing them from all responsibility during the electoral period. Given a mature age and a sturdy determination to succeed, the position of a parliamentary candidate certainly falls within the category of dangerous occupations. The wonder, indeed, is that a larger



FIG. 4.—AUSTRALIAN BEAR, OR KOALA.

country or at sea, are not as healthy as farmers or fishermen, and painters and plumbers, who are almost constantly exposed to noxious vapors and suffer more or less at all times from chronic poisoning, die comparatively young.

Tailors and shoemakers, who not only live in a foul atmosphere, but also sit all day in such a cramped position that respiration and digestion are interfered with, as well as drapers, wool and cotton workers, cutlers, file makers, and printers, are liable to phthisis. Liquor sellers and hotel waiters are extremely short lived, their death rate being respectively two and three-quarters and four times as great as that of clergymen.

Railroading and other occupations requiring one to be more or less constantly on the road are extra hazardous, not so much because of the accidents to which one is exposed, as because of the continued jarring, the superheated and foul air in the car and severe draughts every time a door or window is opened, and the fine dust which settles not only in the air passages, but almost completely clogs up the pores of the skin, throwing extra work on the kidneys and giving rise to the so-called "railroad kidney." For this reason, as well as for the broken sleep and irregular meals, commercial travelers are undesirable life insurance risks.

To be a capitalist, whether busy or idle, is somewhat risky; for, besides being a target for dynamite bomb throwers, if busy, the physical wear and tear and the mental strain and anxiety of speculations will soon shatter both your mind and body, consigning you



FIG. 5.—AUSTRALIAN KANGAROO.

either to the madhouse or a premature grave, and, if idle, dissipation or *ennui* are apt to finish you early.

This being a general election year, we should fail in our duty to the public if we did not remind our readers that they may also in their official capacity warn the people of the dangers to which the politician is exposed. On this subject we cannot do better than to quote an editorial in the *Medical Press and Circular*, June 23, 1892:

"The excitement associated with an approaching

FIG. 6.—AUSTRALIAN CAT (*Dasyurus* *Mauget*).

and missiles of a similar description, to be treated *sec. art.*, the excitement and the exhausting physical exertions which canvassing and electioneering entail upon the candidate and his chief agents determine a tangible proportion of breakdowns. It has often been

number do not give way under the strain, but the effects cannot be measured by the immediate mortality. The moment seems opportune to advocate the value of bloodletting in heart failure. Such an operation, carried out on a public platform with prompti-



FIG. 7.—A PASTURAGE IN AUSTRALIA—QUEENSLAND CATTLE EN ROUTE FOR THE MARKETS OF THE SOUTH.

noticed that the election is barely over before a certain number of the candidates collapse and are forced to retire from active political life. Indeed, one is surprised that life assurance companies do not insert into the conditions of the grant of a policy a saving clause relie-

tude and dispatch on a syncope chairman or lecturer, would be enough to secure a popular reputation for the operator, especially if by good luck the victim survived the ordeal."

Several defeated presidential candidates have lain



FIG. 8.—TRANSPORTATION OF MERCHANDISE IN AUSTRALIA BY MEANS OF OXEN.

down and died shortly after their defeat, and Generals Garfield and Arthur might have been alive to-day had they left politics alone.

From what we have said, it follows that, if you would enjoy a happy life, as well as a long one, and be prepared to go to a better place when your time comes, practice not, but rather preach; spend not your days in houses built by man, but under God's fair sky; seek not wealth, for "it is easier for a camel to go through the eye of a needle than for a rich man to enter the kingdom of heaven;" keep the ten commandments and read and heed daily the divine injunction: "Take no thought for your life, what ye shall eat, or what ye shall drink; nor yet for your body, what ye shall put on."—*Pac. Med. Jour.*

(Continued from SUPPLEMENT, No. 874, page 10000.)

LIFE SAVING APPLIANCES.

FOUR months ago, after the series of maritime casualties which culminated in the stranding of the North German Lloyd steamship *Eider*, the proprietors of the *London Graphic* and *Daily Graphic* offered a reward of £100 to the inventor of the best means of communicating between a stranded ship and the shore or a boat. After a careful investigation of the schemes submitted for competition, Rear Admiral Seymour, C.B., Captain Vyvyan, R.N.R., Elder Brother of the Trinity House, and Captain Wyatt, formerly of the P. and O. service, who kindly consented to act as judges, have presented the following report:

To the Proprietors of the *Daily Graphic*:

Gentlemen: We, the undersigned, being the honorary committee convened for awarding the prize of £100 offered by you "to the inventor of the best means of communicating between a stranded ship and the shore, or a boat," have now completed our examination of the inventions sent in, and made certain experiments on them; and having formed our judgment, we beg to forward to you the following report:

I.—STATISTICAL.

Between the 6th of February, on which day you first advertised your offer of the prize, and the 31st of March (inclusive), when the competition was closed, 1,809 projects were received, and after March 31st about 300 more were sent, but too late for consideration, making a total of about 2,200 in all, thus showing plainly the public interest evoked by your generous offer. The following summary of the 1,809 different letters of inventors examined by us may be of some interest. But we would first say that not more than 100 inventions in all came from outside the United Kingdom. Of these most came from Germany or Austria, and some from France, while the number from the United States was very few.

II.—CLASSIFICATION OF SCHEMES.

No.	Short Title of Invention.	No. of Schemes.
1	Buoys.....	262
2	Torpedoes.....	242
3	Kites.....	239
4	Ship guns.....	167
5	Ship rockets.....	165
6	Mechanical boats.....	151
7	Balloons.....	124
8	Boats, ordinary.....	97
9	Life rafts.....	49
10	Combinations of balloons, kites, ship guns, and ship rockets, with boats, buoys, life rafts, or torpedoes.....	45
11	Arbalests, catapults, and spring guns.....	43
12	Birds and dogs.....	39
13	Ship mortars.....	27
14	Cranes, bridges, etc.....	27
15	Nonsensical proposals not worth specifying.....	23
16	Lifeboats.....	19
17	Parachutes.....	17
18	Rockets from shore.....	15
19	Harpoons.....	13
20	Proposals for spreading oil on the sea to calm it.....	11
21	Gun on shore.....	11
22	Aerial machines.....	9
23	Electrical appliances for communicating.....	8
24	Submarine sentries.....	5
25	Telephones.....	3
26	Others.....	2
27	Fantastical and miscellaneous ideas.....	98
28	Details too meager for classification.....	36

Total number of inventions sent in. 1,936

III.—NUMERICAL CLASSIFICATION.

It will be noticed that there are thirty-seven more inventions than inventors' letters. The reason of this is that some letters contained more than one invention. As regards numerical classification we may make four divisions, the first over 200, including the three sorts of invention which seem most to appeal to the public fancy, namely, buoys, torpedoes and kites; the second, those over 100, of four sorts, namely, guns, rockets, boats and balloons; the third, those over 40, of four kinds; and the fourth, of seventeen descriptions, with less than forty in each.

IV.—EXPLANATION OF CLASSIFICATION.

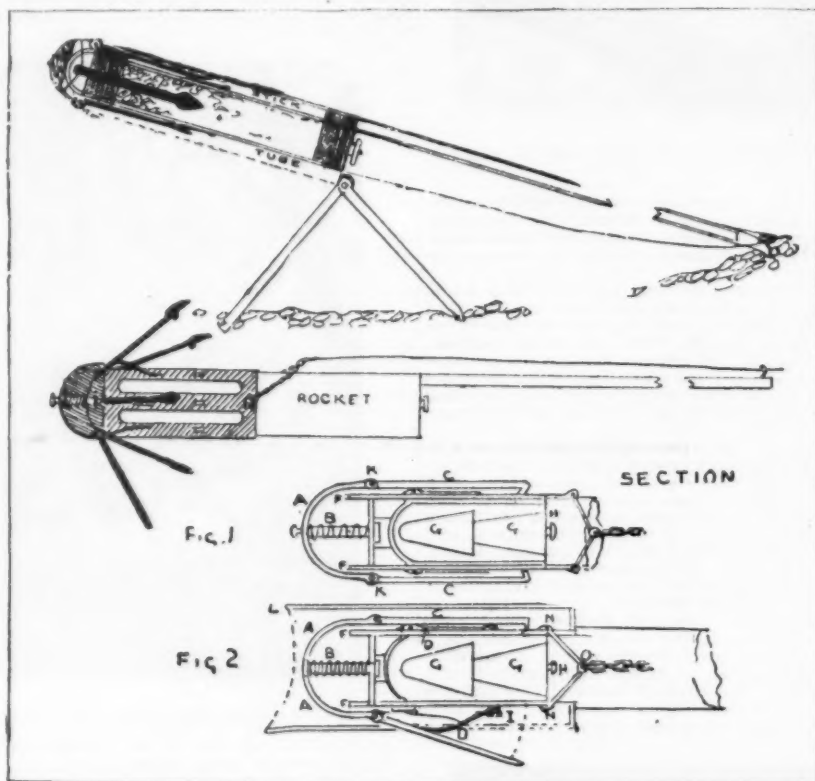
1. *Buoys* (262), which are the most numerous class, vary immensely in kind; under this head being grouped those proposals to float lines on shore by something that is not a boat, and that should not take one or more men as well as the line. 2. *Torpedoes* (242) nearly describe themselves, they being for the most part submarine machines, often on the general lines of a Whitehead torpedo, impelled by machinery, and having a line fast to them which is to be towed on shore; and many being further complicated by carrying anchors, grapnels and time-fuse rockets to throw lines on landing. The great expense and complication of torpedoes are alone fatal objections to their common use in merchant vessels. 3. *Kites* (239) are of many sizes and various materials; some are intended to carry grapnels and even anchors on shore suspended to their tails; others to tow buoys, with or without grapnels, and drag lines to the beach. 4. *Ship Guns* (167) include every firearm of whatever

size, whether cannon, musket or pistol, but not being a rocket or a mortar, devised to throw a projectile with line attached from ship to shore. 5. *Ship Rockets* (165) are all rockets designed to be fired from the ship to the shore with a line attached to them. 6. *Mechanical Boat* (151) means a boat that is to carry one or more men, with propulsive mechanism worked or superintended by them. 7. *Balloons* (124). Always to be sent from the ship; of various sizes, very seldom to carry men; but often to take anchors or grapnels on shore. 8. *Boats, Ordinary* (97), that is, those without mechanism, and not lifeboats; intended to carry lines on shore, impelled by either oars or sails; sometimes in the latter case without men. 9. *Life Rafts* (49). Various contrivances to construct rafts for carrying people. Generally of ship's furniture, to be fitted originally for the purpose. 10. *Combinations of Balloons, Kites, etc.* (45). Under this heading are contained different combinations, so complicated in most cases as to be quite impractical. 11. *Arbalests, etc.* (42). Under these are classed all contrivances to shoot projectiles, with lines attached, without the use of any explosive substance. 12. *Birds and Dogs* (39). These are proposals to employ trained dogs, or birds of various kinds, mostly pigeons and sea gulls, to carry a line to the shore. 13. *Ship Mortars* (27). To throw a projectile, with line attached, from ship to shore. 14. *Cranes, Bridges, etc.* (27). These are the most crude and impracticable suggestions that can well be imagined, and are hardly worthy of serious notice; they pretend to aim at establishing connection, sometimes starting from the ship, sometimes from the shore, by contrivances of the above descriptions, the bridges often consisting of a series of rods to be attached to each other like a chimney sweep's brush. 15. *Nonsensical Proposals, etc.* (23). One or two of these are evidently jokes; others emanate from children, the tenor of whose letters, as well as the certificates of

lightships, buoys, etc., by means of which wires the news of disaster to ships, and their need of assistance, may be sent to stations on shore. 24. *Submarine Sentries* (5). This may be generally described as analogous to the invention of that name which was in the late Royal Naval Exhibition. We need not remark that it is wholly inapplicable to the terms of the reward offered. 25. *Telephones* (3). These are proposals to send on shore from the ship a fine wire, to communicate by telephone with those on shore. 26. *Others* (2). We have used this fishing tackle term to imply a contrivance which is to be drifted at an angle to a current setting along the land, and thus convey a line to shore. 27. *Fantastical and Miscellaneous Ideas* (98). Such are proposals for men to be dressed in divers' dresses with lines attached to them; lowered to the bottom of the sea, and sent to walk on shore, and thus make communication. Also for men to be fired from a cannon, on the same principle as Zazel at the Westminster Aquarium some years ago; and many others not worthy of serious descriptions; though, might we further occupy your valuable columns, much humorous matter could be abstracted from the above. 28. *Details too meager for classification* (36). These comprise vague, ill-defined schemes, sometimes for the prevention of the ship's grounding, sometimes for her preservation after being stranded, and other chimerical ideas for landing the crew or passengers, but so ill considered or badly described that no fixed plan can be elucidated from them.

V.—ECCENTRICITIES OF GENIUS.

We should trespass far too long on your time and space if we attempted to give an idea of the different eccentricities of genius at all adequate either to their variety or their impracticability; so we will only venture to allude to two or three of them. Such proposals as dropping a penny in the slot, and being thereby



THE ROCKET GRAPNEL, DESIGNED BY MESSRS. NOBLE & THOMSON, TO WHOM THE PRIZE OF £100 HAS BEEN AWARDED.

The above sketch gives different views of a rocket grapnel, the invention of Messrs. Noble and Thomson, of Southampton, to whom the prize of £100 has been awarded. The top sketch represents the grapnel and rocket in position ready for firing. The second represents the rocket after being fired, the grapnel having opened out as soon as the ground was touched. The two lower figures show sections, Fig. 1 of the grapnel and Fig. 2 of the rocket fixed on the rocket tube. A is the head of the cap or grapnel; B, the spring to relieve the arms when required; C, arms of

grapnel; F, bolts from head to tube for spring; D, side springs to push out arms when required to grip; I, is the tube which passes over the rocket, and forms the shell of the entire grapnel; G, charge in the rocket; H, fuse; I, the slot for keeping the arms in position before firing; K, hinges and stops for arms of grapnel; N is the connection wire to swivel O, which is attached to the grapnel tube, and conducted by the wire line to the rocket line at the end of the stick, which always holds good when the rocket line gets burned next to the rocket.

their fond parents alike testify to the immaturity of their ages and intellects. 16. *Lifeboats* (19). These include ideas for launching lifeboats from the shore in bad weather, and also suggestions for such boats being carried on board ships. 17. *Parachutes* (17) are in construction what the name implies, though their intended action is quite different, they being meant to leave the ship with a fair wind to the shore and a line tied on to them. 18. *Rockets from Shore* (15). Some of these might, perhaps, be applied for ship's use also. They are mostly described as improvements on or enlargements of the present Board of Trade L. S. A. rocket. 19. *Harpoons* (13). These are proposals for projectiles only, of a harpoon shape, without any distinct description of the means for their propulsion. 20. *Proposals for Spreading Oil on the Sea* (11). Besides the fact that these are, of course, inapposite to the terms of the competition, we may also remark that, though in deep water oil so used has a wonderful effect in preventing the sea from breaking, it is almost useless among breakers or in shallow water. 21. *Gun on Shore* (11). As remarked about "Rockets from Shore Only," some of these might also be used from a ship. 22. *Aerial Machines* (9) are contrivances to travel in the air by the use of sails or wings, and thus convey lines from ship to shore; one or more people are intended to work them. It need hardly be remarked that, like many other proposals submitted to us, the aerial machines are figuratively, but not literally, "in the air" at present. 23. *Electrical Appliances for Communicating* (8). These mostly consist of vague and fanciful schemes for a system of electric wires to surround our coasts, or parts of them; being led off to

shot into the air and landed on the beach; or a hollow air-tight mast, with a staircase up it inside and a water-tight ship's deck, which will allow the crew to live inside the ship at the bottom of the sea till aid comes, so long as the masthead protrudes above water, with various other conceptions of the human mind germane to them, are relegated to No. 15, "Nonsensical Proposals;" while the so-called "lighted dog," which is an aquatic member of the canine species, to be carried in every ship till it is wrecked, and then committed to the deep with a lantern round its neck if at night, and a line in all cases tied to its collar for it to take on shore, is with other quadrupeds and bipeds classed under No. 12, "Birds and Dogs."

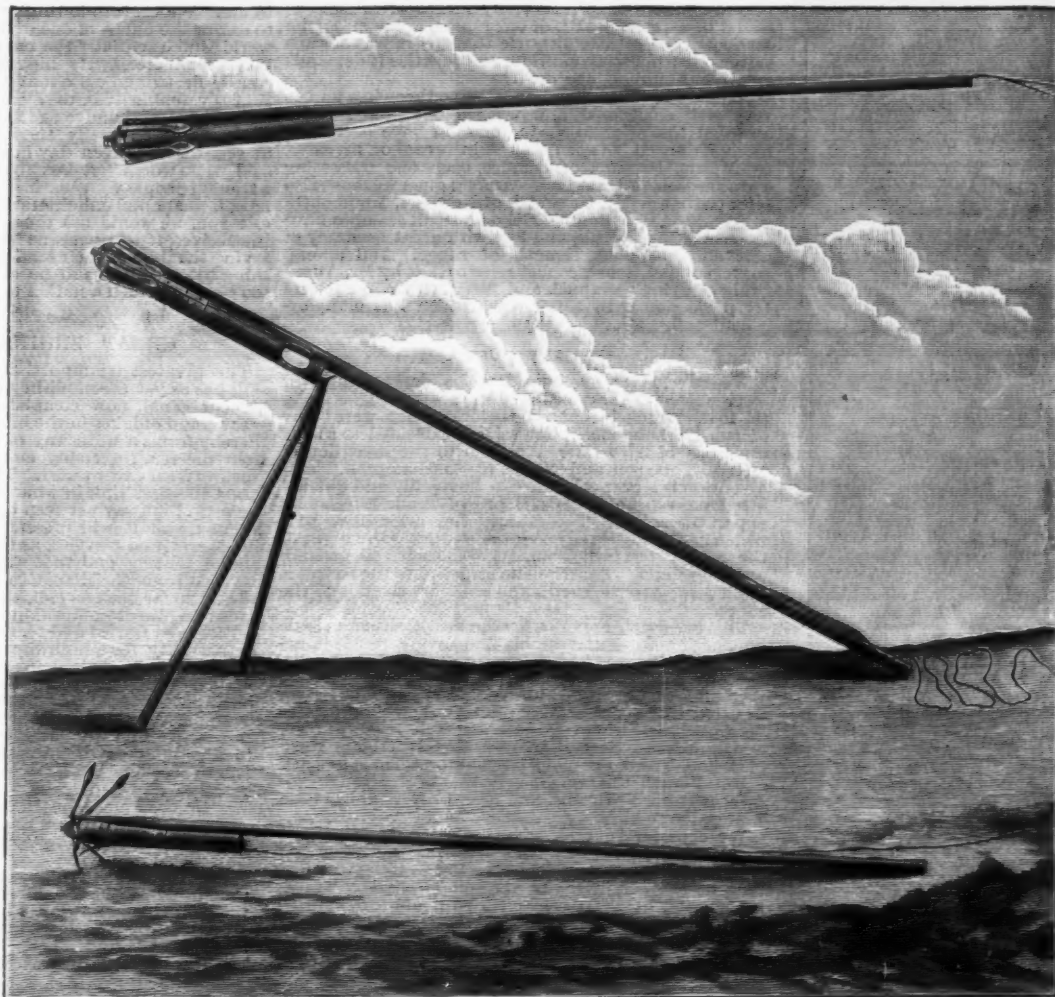
VI.—QUALIFICATIONS.

In considering our award we have been generally guided by the four following qualifications in the order in which they stand: 1, Efficiency; 2, Simplicity; 3, Portability; and 4, Economy. We are also most anxious to afford in case of shipwreck some means of escape to land that shall not necessarily be dependent on the presence of any inhabitants to aid on the shore; their presence being a postulate which, we think, is far too often assumed by inventors of plans to save life from a wreck. It may be allowed that the majority of shipwrecks do occur not only on inhabited shores, but on those most civilized; which follows naturally on the fact that commerce seeks chiefly rich and populous lands; and the concurrence is fortunate for those wrecked, as affording the best chance of their being saved. But shipwrecks may and do also happen on shores very sparsely peopled, or even unin-

habited; and it is also to these, the worst conditions, that we think the best inventions ought to apply, more especially if, as we believe, their doing so does not lessen their efficacy under other circumstances. This consideration has very greatly influenced us in our decision, and its corollary is that the ship herself should carry some means of escape for the crew. Of the four qualifications—efficiency, simplicity, portability and economy—the first and last seem to speak for themselves. Yet, as regards “efficiency,” which is the most important of all, we should explain our views, only premising that we start with the axiom that no one contrivance can be the best specially applicable to every variety of circumstances. It appears, then, to us, that the most “efficient” plan is that which will act under the most different circumstances—as to wind, whether it is blowing with violence or moderation, if toward, from or along the land, or in a calm; the state of the sea, its violence, its currents or set; the kind of shore a wreck takes place on, whether a shelving beach of sand or shingle, or on rocks; or under a cliff with deep water at its base; whether there is a steady shoaling of the water, or if off-lying shoals exist; also whether on the shore there are civilized and friendly people trying to render all the aid they can; or if the ship is cast on a savage or uninhabited land, where the only hope of safety for her crew depends on their own resources and their individual exertions. We would again remark (as stated above) that of the many inventions submitted to us no one sort only can be said to be better suited to every and all possible conditions than some other may

tages sought for, and may be independent of shore help; but they require a wind fair or nearly so, and the best type of kite is not fitted with a grapnel. 4. *Ship Guns* (167). We have long debated the comparative merits of these and ship rockets, and it is very remarkable that the numbers of these two kinds of invention should be virtually the same (namely, 167, 165 respectively); it may be supposed to show how nicely the question is balanced generally. The advantages of guns seem to be—(a) Their independence of wind, sea, weather, and kind of shore, so long as it is within range. (b) The quickness of their action. (c) In many sorts comparative simplicity. (d) The gun might be used also as a signal gun. 5. *Ship Rockets* (165). have in their favor in common with a gun much of the first three advantages claimed for the latter. But the pros and cons of rockets compared with guns will be considered further on. 6. *Mechanical Boats* (151). We consider the expense and complication of these enough, in many cases, to condemn them, besides which their success would often be impossible, generally unlikely, and always uncertain and slow. 7. *Balloons* (124). We are surprised at the great number of these, considering their impracticability. Their extreme fragility is alone enough to condemn them for rough ship work, and still rougher shipwreck. Added to which any one who has ever “assisted” at the ascent or the descent of a balloon in a fresh breeze of wind would be sorry to depend on one for safety in a gale. 8. *Boats, Ordinary* (97). It is perhaps natural that there should be many of these, though it may be questioned how far some of them come under the head of an invention. But set-

quired for discarding these. 16. *Lifeboats* (19). What we have said of No. 8, “Boats, Ordinary,” mostly applies to these also; and we think it needless to say more. 17. *Parachutes* (17). Our remarks on kites and on balloons apply mostly to these also; to which we may add that, while their perpendicular course is by some people thought uncertain and attended with much risk, we doubt greatly if any dependence could ever be placed on the horizontal flight of a parachute. 18. *Rockets from Shore* (15). We cannot feel satisfied with a means of communication that depends entirely on people and contrivances on shore, as stated above in Paragraph VI. of this letter. Nor would it touch the second part of your offer at all. 19. *Harpoons* (15). The crudeness of these suggestions quite precludes their serious consideration. 20. *Proposals for Spreading Oil on the Sea to calm it* (11). It is sufficient here to notice the fact that this does not come within the terms of your offer. 21. *Gun on Shore* (11). With regard to this idea we need only say that the same remarks apply as to No. 18, “Rockets from Shore.” 22. *Aerial Machines* (9). At the present very elementary stage to which the practice of aerostation has yet arrived, it will not be supposed that any of these proposals have claimed our serious attention. 23. *Electrical Appliances for Communicating* (8). The inventors of these seem to have taken the word “communication” in your offer to imply the transmission of words, not things or people; [we confine it to the last sense, and for that reason (as well as others) discard these inventions. 24. *Submarine Sentries* (15). However well these may carry out the benevolent inten-



FIGS. 3, 4, AND 5.—LIFE-SAVING ROCKET GRAPNEL.

specially be. For instance, given a fair wind and a shelving beach, some of the proposed inventions, such as boats, buoys, or even torpedoes, might land there on a line for friendly hands to grasp and secure. But such a plan could not possibly answer at the foot of a steep cliff; nor probably on a rocky beach, where anything approaching the shore would be beaten to pieces. Likewise, with a fair wind, a kite, a balloon, or a parachute, if once safely got away from the ship, might waft a line to land; over a very considerable distance, too, especially if a buoy were used to act as an intermediate float for the line between the wreck and the aerial pulling engine. But a wind either foul, or blowing at a considerable angle to the possible landing place, or no wind at all, would entirely preclude all chance of success from the use of any one of the last three devices named.

VII.—DISQUALIFICATIONS.

We will now briefly give our reasons for discarding certain inventions. 1. *Buoys* (262) appear to us to be, 1. Far too uncertain in their action. 2. Far too slow, even if they finally succeed in landing a line. 3. Too dependent on special conditions of wind, current, state of sea, and sort of beach; and 4. To be dependent on the presence of other people on shore. 2. *Torpedoes* (242) are practically out of the question, owing to their great cost and complication; they are useless if not handled with constant and skilled care, with the utmost perfection of which they would only run up on to the most favorable beaches; and then in most cases would require shore help. Except some other half dozen proposals, we think these the most impractical of all; it is therefore very curious that they come second in number. 3. *Kites* (239) have the last three advan-

ting that aside, we need not enlarge on the difficulty of safely beaching a boat on a lee shore in a gale of wind, and probably with no shelter at all. 9. *Life Rafts* (49). These seem to us as barely within the terms of the offer, and to belong rather to the question of a ship foundering out at sea than as a means of communication from one that is stranded. 10. *Combinations of Balloons, Kites, etc.* (45). These lack generally the clear-headed straightforwardness that an invention of practical merit must have; and their want of simplicity alone is in many cases enough to condemn them. 11. *Arbalists, etc.* (42). Although modern science declares that for the destruction of human life explosive substances are vastly superior to spring guns *et hoc genus omne*, it might, perhaps, not follow that they are so for life-preserving purposes too. Nevertheless, we prefer in all cases the more recent inventions for propulsive power. 12. *Birds and Dogs* (29). We consider the *prima facie* evidence to prove many of these to be genuine proposals, though they are also impracticable as to be unworthy of serious consideration. 13. *Ship Mortars* (27). A mortar may succeed in throwing a line with fair precision; but its range, management, and direction require more skill than a gun does; and we do not think it nearly as reliable as either a gun or rocket. Mortars, as is well known, were formerly used to throw lines to wrecks, but were discarded in favor of rockets, presumably as the result of experiments. 14. *Cranes, Bridges, etc.* (27). If a wreck were fixed for an indefinite time off a weather or sheltered shore, with money no object, some of these contrivances might afford scope for ingenuity, and possibly be instructive; but we cannot regard them as expedient for the object now sought. 15. *Nonsensical Proposals, etc.* (23). No reason is re-

tions of their inventors, they are, of course, wholly irrelevant to the terms of your offer. 25. *Telephones* (5). With regard to these, it is sufficient to say that we desire to repeat our remarks on 23, “Electrical Appliances.” 26. *Otters* (2). To these, which are in fact “buoys” with a complication, our remarks on No. 1 invention also apply. 27. *Fantastical and Miscellaneous Ideas* (98). These belong rather to the regions of fancy or poetry than of practical work and usefulness. 28. *Details too Meager for Classification* (36). It is almost superfluous to say that no practical suggestion has been extracted from these.

VIII.—ADVANTAGES OF THE LINE AND GRAPNEL.

And now, having considered in turn all the inventions submitted, it remains for us to sum them up and make our award. To avoid repetition, we would beg you to keep well in mind what we have said in section VI. of this report, and which may be briefly summarized as seeking these objects: (a) Efficiency, simplicity, portability, economy; (b) Ship to carry her own means of escape for the crew; (c) A method that shall be applicable to as many variations as possible of wreck, const, sea, wind, and weather; and (d) A means that shall be as independent as is feasible of whether the land is inhabited or not.

To fulfill entirely and to universal satisfaction all these conditions is manifestly impossible, but we consider that the most generally applicable, the quickest, and the most reliable way of “communicating between a stranded ship and the shore” is by firing a line from the ship to the land; because in the worst wrecks, namely, those on a lee shore, this means firing with a fair wind, the projectile carrying this line having a grapnel on it, which on falling shall grip the surface of

the ground, and thus secure the shore end of the line. This line may be either single or double, as the distance from the shore permits. If double, and the grapnel bites, communication is effected; and by means of the whip a larger grapnel and rope may be hauled on shore. The importance of this on an uninhabited or unfriendly coast is obvious.

Should, however, it be practicable only to fire a single line, if a life-saving apparatus exists on that part of the coast the ship is wrecked on, it may then be applied as usual. If there is none, but there are friendly and intelligent people on the shore, they may by means of the line haul on shore from the ship a stouter rope or hawser to effect better communication with. If there is no such succor on the beach, a man must next try to land with the help of the line that is now stretched to the shore; he should take with him a small single block and the end of a small line, rather longer than the distance from the ship to the shore. Having landed, he should first see the grapnel well secured, then attach the block to it, reeve the end of the first line through the block, and secure it to the small line he brought with him. Those on board then haul on the latter, and thus send to shore a stout rope or hawser, bent on to the ship end of the first (that which was fired from the ship); the man landed secures this, and the rest of the crew proceed to get on shore in such manner as seems best according to circumstances.

IX.—GUN VERSUS ROCKET.

Having said that we decide in favor of firing a line from the ship to the shore, attached to a projectile that

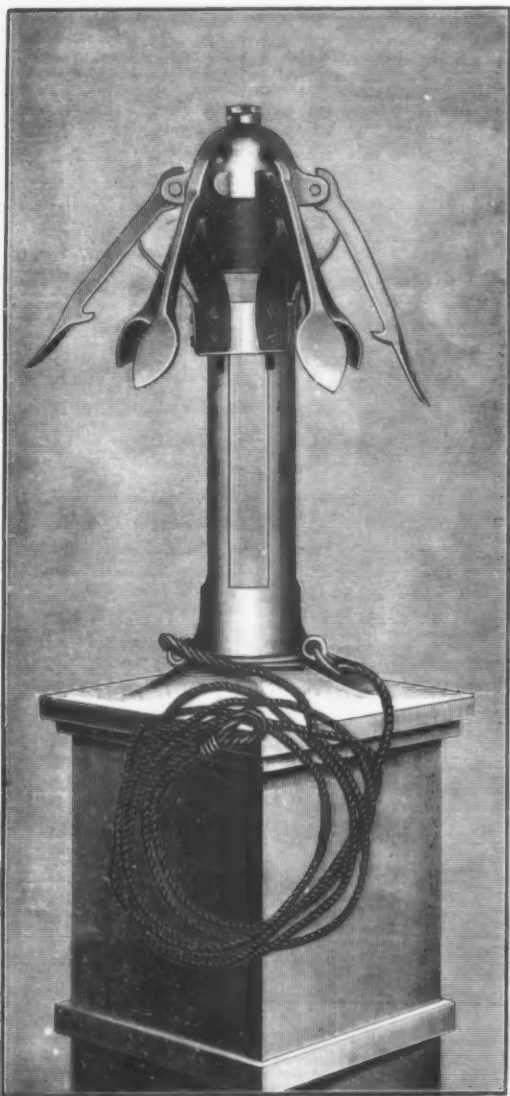


FIG. 6.—LIFE-SAVING ROCKET GRAPNEL.

shall carry a grapnel, we must now state what means of projection we prefer. This question gradually resolved itself in our minds to one between "ship guns" and "ship rockets," and we have well considered this point. There is much to be said in favor of both. The following may be taken as a very brief summary thereof; but more arguments could be easily adduced:

GUN.—Pros. The accuracy and range of a gun would probably be better than those of a rocket. The projectile from a gun would not be acted on and diverged from its course by the wind as a rocket would be. Its ammunition is easier to keep well and less liable to injury and deterioration than rockets. A gun could be used also as a signal gun. Cons. The projectile starts with its maximum velocity, which is liable to snap the line at starting. It is also apt to break the line during its flight if the line gets checked by any means. It is a very violent way of going to work. For long ranges the initial velocity must be very great, because it is being constantly diminished by the drag of the line. An efficient gun is very expensive. A gun (cannon) is heavy and awkward to move about the stranded ship, perhaps on her beam ends or rolling heavily, or to secure and fire in unusual positions.

ROCKET.—Pros. The rocket starts slowly and gradually, and increases its velocity during its flight, which seems to be a very satisfactory method of procedure, and much less likely than a gun to part the line. It is much lighter than a gun to move about, and far easier to point in any direction required, especially under ad-

verse circumstances of shipwreck. Its tube is cheaper than a gun. Cons. A rocket (like a Whitehead torpedo) is very difficult to keep straight. Carrying its own impulse, if it once begins to diverge, from wind or other cause, it may describe half a circle even, which the shot from a gun could never do. There is danger of a rocket bursting from the effects of chemical action or rough usage. No rockets over five years old should be fired. We may add that guns are used in the United States and by some other countries for line throwing, and we have seen practical trials of some, which we must briefly refer to later on. Rockets, in addition to their intrinsic value as carriers, have the recommendation of being well known and tried as such for many years round the coasts of the United Kingdom, and are not by any means an experiment. We think them also less dangerous to fire toward land where people may be collected than a gun would be, because their flight is usually slower than that of a projectile from a gun; and at night the back fire proceeding from them indicates their position and direction.

X.—HONORABLE MENTION.

A competition like this could not be brought to a close without a delicate mesh of merit very hard to disentangle; and, as we have just said, we cannot end our report without referring to a very few of the inventions we have seen practical trial of. It was the desire to have some trials that have delayed our final decision. Among these we would specially refer to the kite invented several years ago by Rear-Admiral Sir George S. Nares, K.C.B., F.R.S., and since improved by him. We have seen this flown, and know it to be a very ingenious contrivance, by means of which, as stated in Paragraph VI. of our report, a line might be carried over a greater distance than by means of guns or rockets; but the conditions and practice it demands are, in our opinion, against it.

Commander J. D'Arcy Irvine's line-throwing gun is very well considered and worked out; and had we awarded the prize to a gun, it would have been very nicely balanced between that and the cannon invented by Messrs. Dawson, of Dundee, each one possessing certain special advantages. Among guns we must also refer to that of Mr. Garwood, of Newport, Monmouthshire, whose ingenious model on a small scale we have seen carry a projectile and line with great accuracy of aim and surprising length of range. And among rocket competitions we must refer to that by Mr. Alfred Craig carrying a grapnel, and fitted with a parachute for projection with a fair wind, which has many excellent points about it.

XI.—THE AWARD.

We have, after due consideration, decided in favor of a rocket as the best means of line projection. Among the 165 ship rockets that came before us there were many of considerable merit, but we have decided to award the prize of £100 offered by you to the invention of Messrs. Thomson and Noble, of Southampton. This invention is a grapnel that can be readily and quickly fitted on to the Boxer's Board of Trade Life-saving apparatus rocket. The grapnel has arms fitted to it which keep shut closely to its sides during the flight of the rocket, but which, on its touching the ground, open out; and, when the line attached to the rocket is hauled on, grip the earth, and so secure the line to the shore.

This invention provides for the use of either a single line, or of a block and double line rove through it, according to distance and circumstances. We have seen the above rocket grapnel tried more than once. We think it a very great advantage that these grapnels can be fitted to the present Board of Trade rocket, for five reasons. First, these rockets are well tried, known, and approved. Second, there is already a large stock of them. Third, the plant for making them is in existence. Fourth, the same may be said of the troughs for firing them. Fifth, the line used with them has been well tested in all ways.

We consider that by following the means described in Paragraph VIII. of this letter, with the use of Messrs. Thomson and Noble's rocket grapnel, the first part of the conditions of your offer—namely, "Communicating between a stranded ship and the shore"—may be accomplished with the best possible chance of success under the greatest variety of conditions; and that the same method would throw a line to or over a boat, which is your second proposition. We also think that this device fulfills the four qualifications mentioned at the beginning of Paragraph VI.—namely, efficiency, simplicity, portability, and economy, so far as anything now before us, that will really carry out the very important task intended, can be expected to do.

XII.—ROOM FOR IMPROVEMENT.

We have, then, after all awarded the prize, not to some entirely new and startling innovation, but to an invention that is to be applied to what may well be called an old friend, namely, the Board of Trade rocket, and that shall fix it to the shore on landing there. Among our other reasons for so doing is the great consensus of opinions in favor of the use of the Board of Trade rocket from a ship that has come before us, independently of the actual 165 so-called "ship rocket" inventions; also the great experience of these projectiles that has been acquired, and the facilities now existing for an unlimited supply of them at moderate cost. Yet we must add that we do not think finality is yet nearly reached, and we believe that a rocket and grapnel, both lighter and more satisfactory, would be evolved in the course of properly-conducted experiments. We think that the Board of Trade rocket line is capable of reduction both in size and weight, thereby adding to the length of range, without too much reducing the required strength. Before concluding our report, we desire, in the interests of seamen generally, to record our opinion that circumstances often arise when a light shoulder line-throwing gun, such as those devised by Messrs. Dawson, of Dundee, and Commander J. D'Arcy Irvine, R.N., would be invaluable, and often be the means of saving life by rapidly taking a line to a man overboard, or to a boat adrift or in distress; also for communication between two ships at sea in bad weather. By such means one vessel might take another in tow without lowering a boat, or might be enabled to save lives from a sinking ship, when a boat could hardly live.

XIII.—AN APPEAL.

In conclusion we desire emphatically to remark as follows: We fully recognize both the humane intention that prompted your philanthropic offer and the amount of interest it has so evidently aroused in the public mind, but earnestly hope the good results will be carried much further than lies in your power or ours. The invention to which we have awarded the prize—even assuming our judgment in doing so to be quite unimpeachable and unquestioned—is probably not the best possible thing of its kind. To find out if it is so, and if not what is, should now be seriously attempted. And we venture to suggest, through the medium of your columns, that a small government grant of money to meet the cost of making a few experiments would be money very well laid out.

We would propose the following: 1. That a small committee (but not the undersigned) be authorized to conduct some experiments. 2. That they be empowered to do four things: 1st. To consider if the Boxer's Board of Trade rocket is the best rocket possible to throw a line from the ship, carrying a grapnel with it. 2d. To make one or more rocket grapnels, as seem to them necessary, for trial. 3d. That they try these not only to ascertain the best ones for holding, but to find out (a) the best distributions of weight for flight and range of the rocket and (b) the best elevations to fire with, under various conditions of wind. 4th. That they consider, try, and report on the best fittings for arranging a rocket tube to be used for firing rockets from different parts of ships, and under varied circumstances; and the line boxes most suitable for use on board ship with them, as well as the best sort of line to use. We venture to think that this is not too much to ask at the hands of one of the richest nations of the world, and essentially the nation that lives by its sea-borne commerce, by its ships and its sailors, whose mercantile fleet numbers about 15,000 vessels, manned by 204,000 valuable lives, to say nothing of the passengers annually carried under the national flag: a nation the value of whose literally "floating" capital, or property at sea, on any given day in ships and their cargoes is said to be worth not less than 200 millions sterling; a nation of people who consider themselves as one of the most humane and enlightened in the world. We would ask you, we would ask them, and beg them to ask of themselves, if to perfect as far as may be the means of saving the lives of their seamen when shipwrecked is a thing too extraneous to be expected of England, and too costly for such a nation to perform.

A GREAT ENGINEERING FEAT.

THE greatest triumph that Norwegian engineering skill has as yet accomplished is undoubtedly the magnificent canal, now completed, which opens up the great chain of lakes in the interior of Telemarken, and thereby forms a waterway of over eighty-five miles from the sea, traversing more than half of Southern Norway from east to west. This canal and water route forms the first link in what must be now regarded as the main highway between the east and west coasts of Norway, and it will present the fewest difficulties to the tourist and traveler, as there are but ninety-seven miles of posting, and that without a break, on the entire road from Christiania to Bergen, a distance of 412 miles. So far back as 1861, the great lake Nordsjo was placed in direct connection with the sea by means of four locks at Lovrid and two at the port of Skien, and the necessity for a highway thence to Stavanger and Bergen was recognized for many years, but not attempted until 1886, owing to the almost insuperable difficulties opposed by nature; but in that year the government decided on its accomplishment, and engineers were found who have, in the most masterly way, brought the forces of nature under control and turned them to account.

A large and rapid river, connecting the chain of lakes in the upper district of Telemarken with the Nordsjo, full of rapids and great falls, was attacked, and is now, by means of weirs and locks, converted into a placid, navigable channel. At the manufacturing village of Ulefus the great fall of thirty-six feet is surmounted by means of three locks and a lengthy aqueduct. The next fall, Eidsfos, of thirty-three feet, is overcome by two locks and a canal quarried out of the solid rock, and a little further on the crowning piece of work is reached at Vrangfos, formerly a series of shoals and rapids over 1½ miles in length, now represented by a mighty fall of seventy-five feet six inches. In order to make the river navigable it became necessary to dam the river at this point and raise the water level to the mentioned height, by which the appearance of the riverside above the weir has become changed, and sufficient depth obtained up to the next fall at Lunde, 4½ miles distant. As no foundation could be got at, a great arch of stone was built across the chasm, forming a base for the great dam of masonry which now confines and controls the waters. The height here is overcome by a set of six blocks blasted out of the sides of the gorge, resembling a flight of stairs. One lock at Lunde and another at Kjeldal raise the waters each 10 ft. and the final series are reached at Hogg, where two locks elevate the channel by 23 ft., and separate the waters of the Bandak from those of the Nordsjo by a distance of over ten miles and a height of 187 ft., at a total altitude of 236 ft. above the sea level. Weirs are built at each fall or rapid, and the level of the water in each section is regulated by simple but efficient means of checking or increasing the flow.

From Hogg the navigation is continued to Stengen, and thence by the chain of lakes, which generally come under the head of the Bandakas Vand, to Dalen at their head, a distance from Stengen of over thirty-eight miles, sixty-eight from Skien, and eighty-five from the sea, amid scenery which becomes more and more imposing the further advance is made inland. The hamlet of Kirkebo, on a side lake, is a perfect oasis in the desolation of grandeur surrounding it. At the sides of the Bandak some curious formations of rock will be noticed, notably those of "St. Olaf's Ship," and the "Monk and Lady," each with its quaint tradition attached. From Dalen, a pretty little spot, the terminus of the steamers, nestling under gigantic heights, a new and wonderfully planned road, the "Bortevrien," some twenty miles in length, has been constructed, forming now part of the main highway over the Hankelifeld

to Roldal, whence branch the roads to Odde, on the Hardangerfjord, ninety-seven miles from Dalen, the route to Bergen and to Sand, on the way to Stavanger. The entire course of this canal and road, now the chief highway between the east and west coasts of Norway, is laid throughout the grandest scenery of Telemarken and Hardanger, and will become one of the most favorite routes for tourists in the whole country. The completion of the canal must be regarded as the greatest triumph yet achieved by the energy and skill of Norwegian engineers, and an event of the greatest interest and importance to tourists and travelers at large.—*London Daily Graphic*.

RADI OF CURVATURE GEOMETRICALLY DETERMINED.

By Prof. C. W. MACCORD, Sc.D.

XIV.—THE CONCHOID.

In Fig. 47, let D be a socket which slides on the horizontal line A B; and let a rod pivoted to this socket slide freely through another sleeve which rotates about the fixed center O. Then a pencil fixed at any point as P or R upon this rod, will trace the curve

C D and C E. Also the triangles C O D, F I O, are similar, whence

$$CO:CD::FI:OF, \therefore CO \times OF = FI^2 \dots (1)$$

Again from the similar triangles C O E, G H O, we have

$$CO:CE::GH:GO, \therefore CO \times OG = GH^2 \dots (2)$$

And dividing (1) by (2), it follows that

$$\frac{OF}{OG} = \frac{FI^2}{GH^2}$$

Consequently the path in question is a parabola of which O is the vertex, and C O produced is the axis. And if as in the figure we make C D = $\frac{1}{2}$ C O, we shall have O F = $\frac{1}{2}$ F I, thus locating the focus F and the directrix L K, the distance of each from O, since F I = C D, being equal to $\frac{1}{2}$ C O.

The direction of the motion of the instantaneous axis at any instant is most readily determined by drawing a tangent to this parabola, availing ourselves for this purpose of the fact that the subtangent is bisected at the vertex; thus, when that axis is at P, draw the horizontal P R, set off O T = O R, then T P is the re-

quired direction, which is therefore very easily found, without actually drawing the parabola at all. Should the instantaneous axis be inaccessible, a tangent to the conchoid may be drawn by Roberval's method, as also illustrated in Fig. 48. Let it be required to determine the direction of the curve at Q, the generatrix having the position Q M O. Assign any velocity M N at pleasure to the controlling point M; this may be resolved into the components M S in the line of the rod, and M J perpendicular to it. The latter is evidently the velocity of rotation about O, and Q V, perpendicular to O Q and limited by the prolongation of O J, is the corresponding velocity of rotation at the given point; which point must also have a component Q W = M S. Completing the rectangle, the diagonal Q U is the resultant direction, and tangent to the curve; a perpendicular to this line through the point Q is the normal, upon which the center of curvature is situated.

Now in Fig. 49, let the fixed point O, the directrix A B, and the constant distance C L, be assumed, as in Fig. 47; and let it be required to determine the radius of curvature at P on the lower branch, the generatrix then having the position P D O, where P D = L C. The instantaneous axis I is found as in Fig. 49, and drawing through I the horizontal I R, set off O T = O R, then T I determines the direction in which the instantaneous axis is moving. Assign to D any velocity

D E along A B; then since the axis I is always in a vertical through D, this vertical must be moving to the right with this assigned velocity, and the actual motion in space of the point I is I H, determined by the intersection of T I produced, with a vertical through E; and I H may be resolved into the components, I J along the normal, and I G perpendicular to it. The point P is moving in a direction perpendicular to I P, with a velocity P U determined by making the angle P I U equal to the angle D I E, since all points of the generatrix are rotating about I with the same angular velocity. Then U G produced will cut P I produced in the center of curvature required. Should this point be inaccessible, draw G V parallel to I P, cutting P U in V; then

$$V U : V G \text{ or } P I :: P U : \text{rad. of curvature at P.}$$

In the same figure, when the generatrix is vertical, the marking point P will be at L, and D will coincide with C. Assign to this latter point any velocity as C E, then O E produced will cut the horizontal tangent through L in the point K, thus determining the velocity L K of the point L in the curve. The corresponding position of the instantaneous axis is the point O, which is the vertex of its parabolic path, as above shown. The motion of this axis can therefore have no vertical component, and is the horizontal O N, = O

FIG. 47.

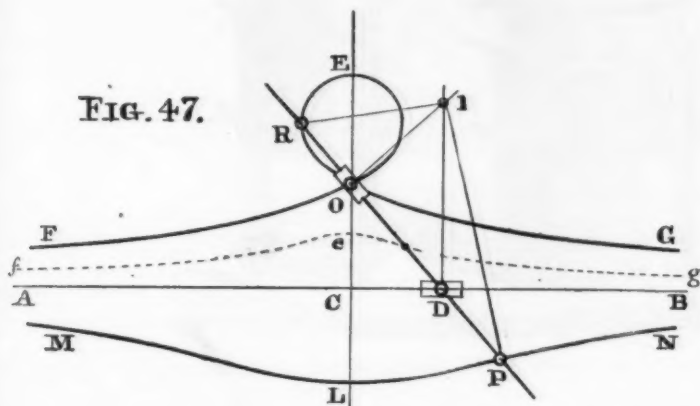


FIG. 48.

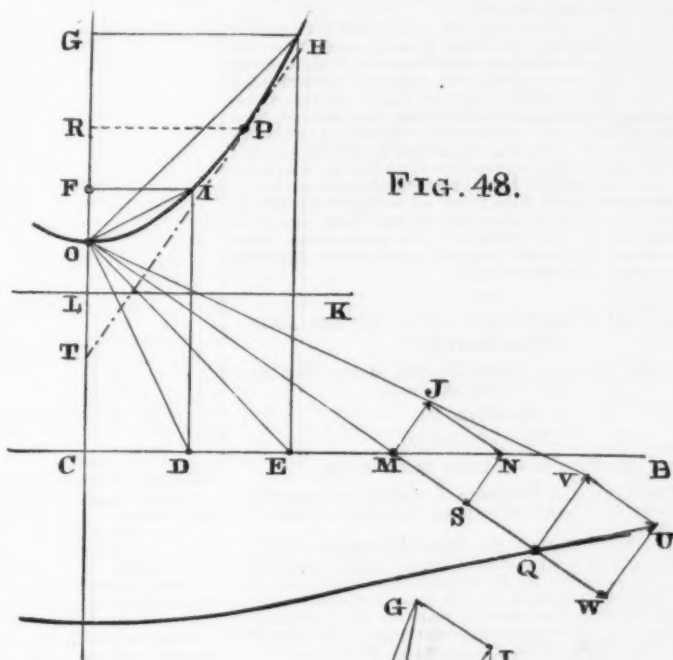


FIG. 49.

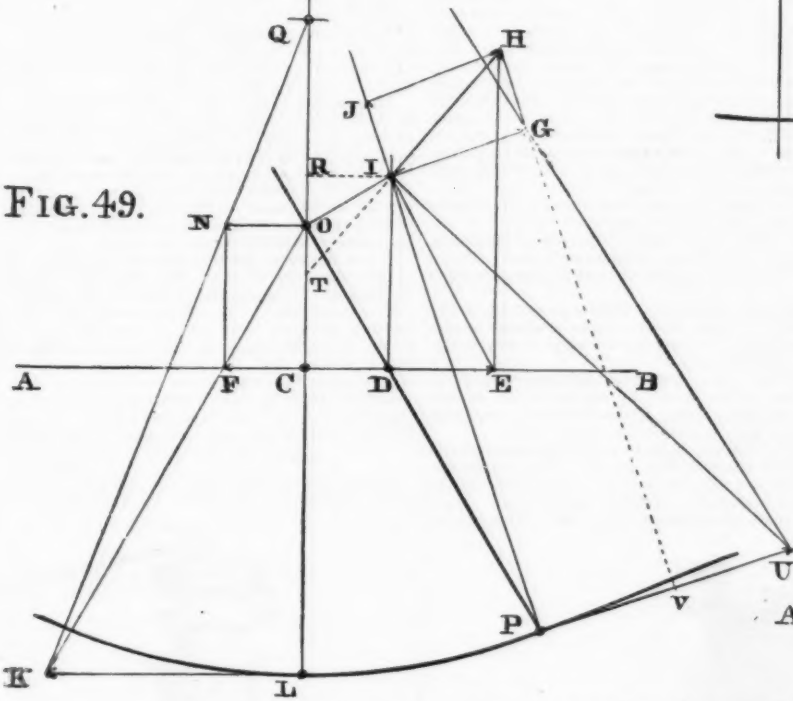
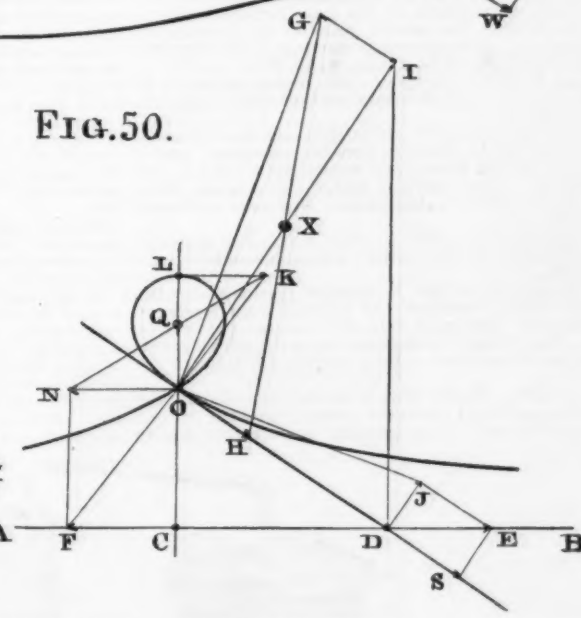


FIG. 50.



RADI OF CURVATURE GEOMETRICALLY DETERMINED—THE CONCHOID.

known as the Conchoid of Nicomedes. Whatever the distance P D, the curve below A B will resemble that shown in the figure, but the upper branch will be looped only when R D is greater than C O; if those distances are equal, a cusp will be formed at O, while if R D be less than C O, the upper branch, as *gef*, will be waved like the lower one; the horizontal line A B being a common asymptote to the two branches.

The instantaneous axis of the moving rod is readily found; it must lie upon the vertical line through D, since that point can move only in a horizontal line; and the point O can move only in the direction of the rod, all side motion being prevented by the sleeve; therefore the axis in question must lie upon a perpendicular to O D, drawn through O, which cuts the vertical through D in the required point I; and I D is normal to the lower branch of the curve at D, and I R is normal to the upper branch at the point R.

Subsequent operations will be facilitated by first determining the form of the path of the instantaneous axis, which may be done as shown in Fig. 49, where the scale is doubled for the sake of clearness. O being the fixed center and C B the horizontal directrix, as before, I and H will be the positions of the instantaneous axis, corresponding to the positions O D, O E, of the moving rod.

Erecting the vertical line through C, the horizontal ordinates I F, H G, are of course respectively equal to

quired direction, which is therefore very easily found, without actually drawing the parabola at all.

Should the instantaneous axis be inaccessible, a tangent to the conchoid may be drawn by Roberval's method, as also illustrated in Fig. 48. Let it be required to determine the direction of the curve at Q, the generatrix having the position Q M O. Assign any velocity M N at pleasure to the controlling point M; this may be resolved into the components M S in the line of the rod, and M J perpendicular to it. The latter is evidently the velocity of rotation about O, and Q V, perpendicular to O Q and limited by the prolongation of O J, is the corresponding velocity of rotation at the given point; which point must also have a component Q W = M S. Completing the rectangle, the diagonal Q U is the resultant direction, and tangent to the curve; a perpendicular to this line through the point Q is the normal, upon which the center of curvature is situated.

Now in Fig. 49, let the fixed point O, the directrix A B, and the constant distance C L, be assumed, as in Fig. 47; and let it be required to determine the radius of curvature at P on the lower branch, the generatrix then having the position P D O, where P D = L C. The instantaneous axis I is found as in Fig. 49, and drawing through I the horizontal I R, set off O T = O R, then T I determines the direction in which the instantaneous axis is moving. Assign to D any velocity

D E along A B; then since the axis I is always in a vertical through D, this vertical must be moving to the right with this assigned velocity, and the actual motion in space of the point I is I H, determined by the intersection of T I produced, with a vertical through E; and I H may be resolved into the components, I J along the normal, and I G perpendicular to it. The point P is moving in a direction perpendicular to I P, with a velocity P U determined by making the angle P I U equal to the angle D I E, since all points of the generatrix are rotating about I with the same angular velocity. Then U G produced will cut P I produced in the center of curvature required. Should this point be inaccessible, draw G V parallel to I P, cutting P U in V; then

$V U : V G \text{ or } P I :: P U : \text{rad. of curvature at P.}$

In the same figure, when the generatrix is vertical, the marking point P will be at L, and D will coincide with C. Assign to this latter point any velocity as C E, then O E produced will cut the horizontal tangent through L in the point K, thus determining the velocity L K of the point L in the curve. The corresponding position of the instantaneous axis is the point O, which is the vertex of its parabolic path, as above shown. The motion of this axis can therefore have no vertical component, and is the horizontal O N, = O

The radius of curvature at any point of this looped curve may be found precisely as was that at P on the other branch in Fig. 49. But when the marking point reaches O, as it must when C reaches D in Fig. 50, making O D = C L, the process may be abbreviated:

because $O I$ perpendicular to $O D$, upon which the instantaneous axis lies, is then normal to the curve. In any case, since $O I$ is always perpendicular to $O D$, it is evident that if $O D$ rotates about O , one component of the motion of the instantaneous axis I must be a rotation of that point about O with an angular velocity equal to that of D . This might have been employed in determining the absolute motion of I in Fig. 49, which could have been accomplished, as shown in previous papers of this series, without reference to the parabolic form of its path; but the method actually used is much more simple and convenient. In the case considered in Fig. 49, it was necessary to determine the absolute motion $I H$, in order to find the side component $I G$. In the present instance it is not necessary, since $I O$ is itself the normal, and the motion of I in rotation about O , being perpendicular to $I O$, is itself the side component required.

And this is readily determined as follows: assign any velocity $D E$ to the controlling point D ; this may be resolved into the components $D S$, $D J$, as in Fig. 48. Then draw $O G$ perpendicular to $O J$, cutting at G a perpendicular to $O I$ drawn through I ; then $I G$ is the side component required.

The motion of the marking point at O is necessarily in the direction $O D$ perpendicular to the normal, and its velocity $O H$ is equal to $D S$; and finally drawing $G H$, that line cuts the normal $I O$ at X , which is the center of curvature required.

It will be observed that the curves $M L N$, *fig.* in Fig. 47, are curves of contrary flexure, since they become tangent at infinity to the directrix $A B$, while at the vertices, L and c , they are concave toward that line. The object of this paper is merely to determine the radius of curvature at any point; but should that become infinite, or in other words should $I G$ prove to be equal to $P U$ in Fig. 49, evidently P must be the point at which the curvature changes its direction. And it may be added, that in a subsequent article it will be shown that this point of contrary flexure in any given conchoid may be located with practical precision by processes which, if not in a strict sense geometrical, are wholly graphic, and easily executed by any careful draughtsman.

THE MANUFACTURE OF LIQUORS AND PRESERVES.*

By J. DE BREVANS, Chief Chemist of the Municipal Laboratory of Paris.

CHAPTER III.

Natural Liquors.

SECTION I.—BRANDY FROM WINE.

Cognac.—Under the name of cognac are comprised six kinds of liquors, known in commerce under the following names:

1. *La Grande Champagne*. (Fine champagne.)—These are the cognacs or brandies most highly esteemed. They are distilled in 29 communes of Charente (department). The center of the manufacture is Segonzac, which fixes the market price on the first day of each month. The average production of this brandy is 115,000 hectoliters, at a strength of 70°.

2. *La Petite Champagne*.—This region comprises 50 communes, of which the center and principal market is Châteauneuf.

3. *Les Borderies ou Première Bois*.—Under this name are comprised the brandy from 90 communes, which produced 200,000 hectoliters before the advent of the phylloxera. The principal centers are Cognac, Hierzac, Jarnac, Matha, Angoulême, Barbezieux, Jonzac, Pons, Saintes.

4. *Les Deuxièmes Bois ou Bous Bois*.—The center of the production of this variety is Rouillac and St. Jean d'Angely.

5. *Saintonge*.—This is brandy produced at the border of the department of Gironde from Mortagne to Rochelle. The most estimable varieties prove to be those vines planted in the interior, as the grapes grown along the shore have a very pronounced taste of the soil.

6. *Rochelle*.—Under this name are included all the brandies produced from vines planted near the sea in a salt, marshy soil. This produces a pronounced taste

tion 120 liters of liquid can be obtained, which is called the *premier brouillis*. This wine, which is exhausted is replaced by wine from the wine heater, which is filled anew. The distillate which is obtained is called the *deuxième brouillis*. A third operation with the same conditions gives what is called the *troisième brouillis*. After the third operation the wine heater is filled with the distilled liquid which has been collected. This is distilled and the *quatrième brouillis* is obtained. The operation is continued as long as there are any traces of alcohol. The working of the apparatus, Fig. 17, will be readily understood without description. The

produces a kind of kirsch, known as maraschino, which differs from kirsch in the kind of cherry employed. The wild cherry (*Cerasus avium*) is indigenous in the forests of the Vosges and the Jura. It is cultivated chiefly on the eastern slopes, where the altitude varies from 500 to 800 meters. Young trees are also raised in nurseries. There are many varieties of wild cherries, but they are not all of equal value for the manufacture of kirsch. The cherries are gathered when they are perfectly ripe. This operation is performed by hand, and an able picker can gather about 50 kilogrammes a day. The harvest continues from eight to twelve days



FIG. 18.—BRANDY STILL WITH WINE HEATER.

still with wine heater is figured in Fig. 18. It is composed as follows: 1 is the still; 2, 3, 4, 5, still head and attachments; 6, swan's neck; 7, the worm in the condenser; 8, 9 is the water funnel; 10, strength regulator; 11, overflow; 12, mouth of the worm; 14 is the water bath; 15, water gauge; 16, wine heater; 17, cover of wine heater; 18, pipe for charging still. The brandy having been distilled, is sold to merchants who doctor it up to suit the taste of consumers and to give it the appearance of age. Not every kind of wood can be used for the casks, preference being given to the wood of Angoulême, which is more aromatic than the wood from places farther north.

Armagnac.—Under this name is comprised brandy distilled in Gers. It is sold at a strength of 52°, but like cognac it is distilled at a higher degree of strength. The manufacturers have very perfect apparatus, which permits of obtaining strong alcohol at the first distillation.

Brandy called Montpellier.—This is prepared in the outskirts of Beziers with choice white and red wines. It is sold of a strength equal to 52° to 66°. The apparatus used is very perfect.

Brandy of Marmande.—Under this name are included brandies made from the white wines in the neighborhood of Marmande. It has become scarce, has a peculiar taste, and is sold at a strength of 52°.

Marc Brandy.—Marc brandy is the product of the distillation of the marc of the grapes. The operation is usually performed with the aid of simple stills. However, improved apparatus is being introduced. Marc brandy has a high standard of about 60°. The principal

The wild cherries are thrown into vats or into casks without heads, placed in a shed or other dry place.

The fermentation begins at the third or fourth day at latest, and continues for about a month. This fermentation ended, the wine is racked off and is not distilled until after fourteen days of rest. During this time the fermentation is finished.

The distillation is generally performed in an ordinary still (*i. e.*, with an alembic). The marc and the racked off juice are introduced in the neck of the alembic, which is then heated. This operation should be conducted with care, to prevent accident. The first portion of the distillate should be of a strength equal to 55° to 60°, and is placed in one vessel, and the second portion, which is intended to enrich the marc, by a second distillation in another.

Plum Brandy (Eau-de-cie de Prunes).—This liquor is prepared in France, Germany, in Hungary and Roumania from special varieties of plums that are called *couetache*. The other varieties of plums give a brandy as good but not as highly esteemed. The mode of preparation is the same as that of kirsch given above, but the product has more commercial importance than the cherry brandy.

Cider Brandy and Brandy from Pears.—This brandy is very highly esteemed in Normandy and Picardy, but is not very well known elsewhere.

SECTION III.—RUM AND TAFIA.

Under the name of rum a liquor was formerly understood which was obtained by distillation from sugar



FIG. 17.—BRANDY STILL.

which improves with age. The center of the manufacture is La Rochelle.

The distillation is made in the winter following the vintage. The product is superior to that obtained by using a wine a year old. The stills used have a capacity of 100 to 500 liters. The apparatus for using the open fire is very crude (Fig. 17). To start the process the alembic or still and the wine heater are filled with wine; 300 liters of wine in each. By careful distilla-

pal centers of production are Bourgogne, Franche Comté, and Lorraine.

SECTION II.—FRUIT BRANDIES.

Kirsch or Kirschenwasser.—Kirsch or cherry brandy is prepared from the wild cherry; cultivated cherries give an equally good brandy, but much less perfumed than the wild cherry. The great centers of the manufacture in France are the department of Doubs, Haute-Saône, and Vosges; in Austria and Hungary, Transylvania, Dalmatia and the Black Forest. Dalmatia

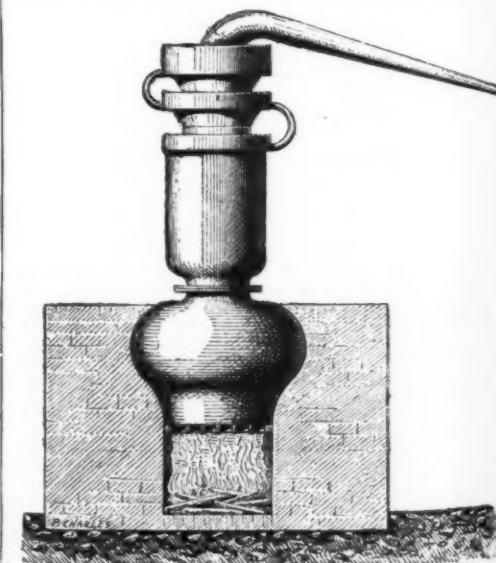


FIG. 19.—STILL FOR TAFIA.

cane. This product has become very rare, and now the name *tafia* is applied to an alcohol prepared from the residues of a cane mill, the scum from clarification, molasses, etc. These materials are mixed with water or, better, with the products of a preceding distillation—a quantity sufficient to raise the must to 6° B. being used. This material is introduced into a vat or cask of

* Continued from page 14111, SUPPLEMENT No. 883.

small dimensions, and yeast is added. The fermentation is quickly done and the wine distilled in very simple stills (Fig. 19). The top is larger than the ordinary still, and is composed of three concentric rings, which augment the condensation of the vapors, and which also prevents a large portion of the odorous principles passing over with the alcohol.

M. Deroy (*Als aine*) has constructed several forms of apparatus for distilling rum more perfectly than the simple still just described. This apparatus (Fig. 20) is composed of three pieces—the heater, which has a large base; the head, with the “elephant’s trunk,” and the worm, which is placed in a tub or in a stone tank. The heater is filled to about three-quarters of its capacity with the material to be distilled; the joints of the head are luted on. The worm is cooled by cold water and the heating is commenced. The distillation is conducted slowly, so as to carry away the aqueous vapors with the alcoholic. The heating terminated, the still is emptied by the cock, 2 (Fig. 20), leaving

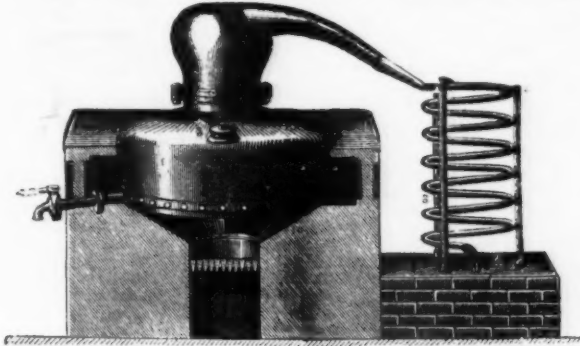


FIG. 20.—APPARATUS FOR DISTILLING RUM.

only a little liquid at the bottom. M. Deroy has also devised two other varieties of stills, one with a wine heater and the other with a wine heater and an apparatus for rectifying.

SECTION IV.—BRANDY FROM GRAIN.

(*Les Eau-de-vie de Grains.*)

In Belgium, Holland and England a brandy is prepared from grain which is known as gin or whisky. The first is made of a mixture of malt and ungerminated wheat; the second, the favorite liquor of the Scotch and the Irish, is obtained from a mixture of malt, rye and oats, or from corn. The distillation of the must is conducted in the manner already described, either with crude appliances or the most perfect apparatus that can be devised. The juniper or juniper brandy is prepared by throwing into the must a certain quantity of juniper berries. It appears that it is not possible to stop the use of these berries in preparing the liquor so dear to the inhabitants of the North.

SECTION V.—THE NATURAL BRANDIES.

A list or table is given below of all the natural liquors that are produced in various parts of the world, with their origin and the principal place of consumption. [Our author's term *eau-de-vie* or brandy is very comprehensive, whisky and gin, for instance, being classed with the brandies.—Ed.]

Brandy, properly so called:

Wine.—France.

Brandy from lees or potatoes:

Glucose.—Northern Europe.

Brandy from beets:

Juice, pulp or molasses from beets.—Northern Europe.

Brandy from rice:

Saccharified rice.—Different countries.

Brandy from grains:

Beers, saccharine grains.—All parts of the world.

Juniper:

Beer, saccharine grains.—Belgium, Holland, England.

Schiedam:

Saccharine grains, fermented, perfumed by juniper berries.—Holland.

Goldwasser:

Brandy from grains, more or less perfumed.—Dantzic.

Whisky:

Rye, oats, corn.—Scotland, Ireland, United States.

Kirschenwasser or kirsch:

Fermented cherries.—France, Germany, Switzerland.

Maraschino:

Cherries, fermented.—Zara.

Zwetschenwasser:

Plums (*couetache*), fermented.—France, Germany, Hungary.

Raki:

Plums.—Hungary.

Rakia:

Mare of grapes, perfumed.—Dalmatia.

Azaka, Arza, Arka, or Arika:

Mare's milk, fermented.—Tartary.

Tafia:

From molasses.—Antilles.

Rack or Arrack:

Must of cane sugar.—Hindostan.

Rum:

Must of cane sugar, molasses.—Antilles.

Aqua-ardiente or Pulque Puerte:

Juice of the Agave.—Mexico and South America.

M. de Brevans names twenty-five additional ones, but they are of little importance, being mostly Asiatic drinks of the Chinese.

SECTION VI.—ARTIFICIAL BRANDIES.

The production of true brandy having decreased and the demand increased is clear proof that a large part of the modern brandies are simply a mixture of alcohol with various substances calculated to give the taste of true brandy. Various receipts are given, but the base of the adulterated article is a mixture of each of

(cashoo, a kind of resin), vanilla, green walnut shells, balsam of tolu, orris, essence of bitter almonds, rum and old kirsch, sirup of grapes, sassafras, broom plant, maidenhair, licorice, etc. In order to obtain artificially the effect of age, it is necessary to make an infusion of oak shavings. This is used in connection with molasses or caramel for coloring matters. (To be continued.)

SMALL OPTICAL THEATER.

WE have already described a room limited by three mirrors, the triangular arrangement of which gave the illusion to several persons entering it together that they were surrounded by a large crowd. This effect, which is very simple, but difficult to obtain on account of the size of the mirrors that it is necessary to employ, can be realized in smaller dimensions in just as curious a manner, and one that permits of modifying the effects and of rendering them artistic, and consequent-

tion and the more powerful the light that enters the box, the better the effect that it is desired to obtain.—*La Nature*.

SOME ADDITIONAL POINTS RELATING TO COMETS.*

By GEORGE W. COAKLEY.†

IN *Astronomy and Astro-Physics*, No. 102, an attempt was made to demonstrate that there was no repulsion by the sun of any portion of a comet. Several mathematical friends of the writer, after careful examination of that paper, have testified their opinion of the solidity of the demonstration. In conducting the argument, the statement was made that a comet may best be regarded as a mass of purely gaseous matter. But the present prevailing view of a comet's constitution is that given by Professor Young in Art. 737 of his “Text Book of General Astronomy, for Colleges and Scientific Schools.” Professor Young states it as follows:

“Perhaps, on the whole, the most probable hypothesis is the one which has been hinted at repeatedly, that a comet is, as Professor Newton expresses it, nothing but a ‘sand bank,’ i. e., a swarm of solid particles of unknown size and widely separated (say pin heads several hundred feet apart), each particle carrying with it an envelope of gas, largely hydrocarbon, in which gas light is produced either by electric discharges between the particles or by some other light-evolving action due to the sun's influence. This hypothesis derives its chief probability from the modern discovery of the close relationship between meteors and comets.”

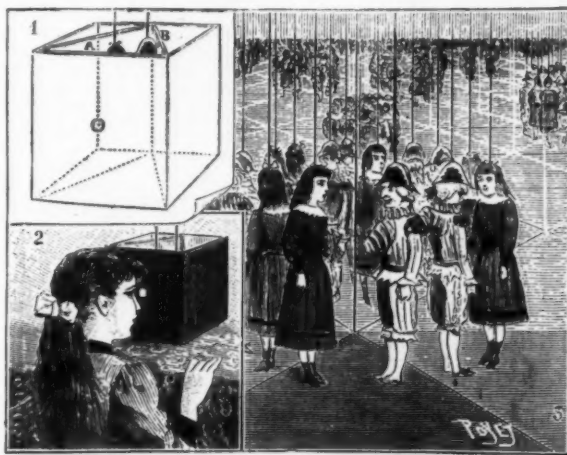
The writer proposes, after disposing of another question, to discuss this theory of comets, proposed by Professor Newton, of Yale College.

Admitting, for the present, Professor Newton's theory, as stated by Professor Young, how does it affect the demonstration in No. 102, that there can be no repulsion by the sun of any portion of a comet?

The particles of this “sand bank,” whether “pin heads several hundred feet apart,” or larger pieces of “gravel,” or great boulders weighing many pounds, or even tons (all of which are required by the supposed “close relationship” between meteors, or rather meteoric stones, and comets), must form first the nucleus and head of the comet, which are always attracted by the sun. Secondly, these particles must also form the train or tail of the comet, stretching away behind the head during its approach to perihelion.

If these “pin heads,” or finer or coarser gravel, or large stones and metallic masses, forming the train are repelled by the sun with a force greater than their attraction by the comet's head and nucleus, then they must be retarded in their approach to perihelion, while the head and nucleus are accelerated by the sun's attraction. They must therefore separate from the comet's head, and move in a curve convex to the sun, because of his repulsion, while the head and nucleus must move in a curve concave to the sun, because of his attraction.

Indeed, just as in No. 102 it was proved that if any of the comet's gaseous matter were subject to the sun's repulsion before perihelion passage it must be entirely sifted out, so that all of the comet that passed the perihelion was necessarily subject only to his attraction, so the same thing must be true of the “pin heads,” or other solid matter. Indeed, it ought to be evident that the demonstration in No. 102 is quite independent of the nature and distribution of the matter composing a comet, provided it be of a sufficiently loose and rare nature. The more solid the particles of which the comet is composed, the more closely they ought to be aggregated by their mutual attractions, and tend to form a single solid body, like the planets, provided the whole number of these particles forms a



SMALL OPTICAL THEATER.

1. Arrangement of the theater with three mirrors, two of which are seen at A and B. 2. External view of the box. 3. Internal view.

spoil the illusion. To this effect, a piece of scenery—a column, some verdure, a branch of a tree, or a garland—is placed where the opening is lost in the painting.

Let us say that too great care cannot be taken to have the mirrors exactly perpendicular to the board that supports them, since, without that, the reflection would be made diagonally and the illusion would not be so perfect.

If the theater thus constructed is concealed in a square box covered with ground glass, or simply with a piece of tulle, in order to allow of the passage of light, without its being possible to see the interior of the apparatus, the combination will not be suspected, and it will be a long time before the spectator gets an idea of the means employed for obtaining so wide vistas in so small a box. The stronger the illumina-

sufficient mass, somewhat comparable to the masses of the planets, though far less.

It seems worth while to consider whether we have not some clearer evidence of the limits of a comet's mass than is generally supposed. La Place has assigned a superior limit, at least of Lexell's comet, which passed very close to the earth, and to Jupiter and his satellites, without appreciably disturbing the motions of either of these bodies. He assigns this comet a mass not exceeding 1-5000 of the earth's mass. Many astronomers have reduced this limit to almost nothing. Professor Young, whose work is quoted as

* Communicated by the author.

† Professor of Mathematics and Astronomy, University of City of New York.

one of the most recent, full and accurate on general astronomy, says: "Some have gone so far as to say that a comet, properly packed, could be carried about in a hat box or a man's pocket, which, of course, is an extravagant assertion. The probability is that the total amount of matter in a comet of any size, though very small compared with its bulk, is yet to be estimated as many millions of tons. The earth's mass is expressed in tons by six with twenty-one ciphers following (6,000 millions of millions of millions of tons). A body, therefore, weighing only one-millionth as much as the earth would contain 6,000 millions of millions of tons." This last is just about the weight or mass of the earth's atmosphere. But in the edition of Professor Young's work from which I quote, that of 1888, he goes on to say, "The atmosphere of the earth alone constitutes about 1-250,000 of the earth's mass, and contains more than twenty-four millions of millions of tons." Here are two mistakes, oversights no doubt, and probably corrected in future editions which I have not seen. The mass of the earth's atmosphere is stated about four times too large, and the consequent value in tons about one thousand times too small. La Place's limit of a comet's mass makes it about two hundred times the mass of our atmosphere. The writer has verified approximately Professor Young's statement of the earth's mass in tons, considering it as a sphere with its mean radius.

The clouds that float in our atmosphere have no definite form; they have not sufficient mass to gather themselves up into any definite shape by their own attraction, whether in a globular mass or any regular geometrical shape. Yet they are capable of pouring down upon the earth many hundreds of tons of water. But when a comet is first seen at its greatest visible distance in a telescope, it usually presents the circular disk of a spherical body. In the case of Donati's comet, when first discovered, it was more than 180,000 miles in diameter. Yet the attraction of its mass must have reached out more than 90,000 miles to cause the particles at its surface to arrange themselves spherically about it. Even after its train was formed, the regular geometric figure of the greater portion of the train shows that the attraction at the nucleus was maintaining a certain equilibrium with the tidal action of the sun in the direction away from him. The action of this mass then extended, with a prevailing force, to some millions of miles from the nucleus, or center of gravity.

Prof. Benjamin Peirce, of Harvard College, was, therefore, more nearly right in his opinion than Prof. Young seems to think, with regard to the amount of a comet's mass. Prof. Young says (Art. 719): "The late Prof. Peirce based his estimate of a comet's mass upon the extent of the nebulous envelope which it carries with it, assuming (what may be doubted, however) that this envelope is gaseous, and is held in equilibrium by the attraction of solid matter in and near the nucleus; and on this assumption he came to the conclusion that the matter in and near the nucleus of an average comet must be equivalent in mass to an iron ball as much as 100 miles in diameter. This would be about 1/250,000 of the earth's mass." This ratio of the iron ball's mass to that of the earth has also been verified by the writer.

Prof. Young says farther: "While this estimate is not intrinsically improbable, it cannot, however, be relied upon. We simply do not know anything about a comet's mass, except that it is exceedingly small as compared with that of the earth."

To this the writer has to say that the equilibrium by the attraction of the comet's mass, at and near its center of gravity, the nucleus, as stated by Prof. Peirce (without the necessity of any solid body there placed), is beyond all doubt; and that, by means of this equilibrium, we do know, from Prof. Peirce's calculation, that the average mass of a comet is very probably the 1/250,000 of the earth's mass, or about 20,000 millions of millions of tons. This is a little more than three times the mass of our atmosphere.

The mass of the earth is sufficient to control the motion of its moon in a relative orbit about its center, at the distance of nearly a quarter of a million of miles. Also the earth's gravity extends many millions of miles to disturb the motions of Mercury, Venus, and Mars. It even has some slight effect on the more distant planets. Hence it is certain that a mass one-millionth part of the earth's mass, like that of our atmosphere, would likewise, as a separate mass, extend its attraction to the distance of millions of miles, though in a proportionally less degree.

Suppose, therefore, that a mass of gas like our atmosphere, containing the same weight of 6,000 millions of millions of tons, were placed as far as Jupiter is from the sun, but moving in a plane highly inclined to the ecliptic, so that it should be far away from all planets of the solar system. Would it not at first gather itself up into a spherical form by virtue of the general attraction of its mass? Owing to the elasticity of the gas, its size would, of course, be far greater than the volume of our atmosphere, which is condensed by the earth's attraction, one million times as great as that of the gas. We should expect it to expand to a diameter of perhaps 200,000 miles, its mean density being very small, but having a greater density at the center of the sphere, or at its center of gravity.

If this atmospheric mass were describing a nearly circular orbit about the sun, it is quite certain, from the formulae investigated in *Astronomy and Astro-Physics*, No. 103, that the sun would exert a tidal force upon it, not only drawing it out into an ellipsoidal figure, with the major axis directed toward the sun, but also transferring the center of gravity of the atmospheric mass toward the sun. This center of gravity of the atmospheric mass, during its revolution, would be always directed toward the sun. The ellipsoidal mass would have a nearly constant figure of equilibrium, depending upon the contest between the attraction of its own mass and the tidal disturbing force of the sun, at that nearly constant distance. The atmospheric mass would also necessarily rotate around an axis through its center of gravity, perpendicular to the plane of its orbit. It would also constantly turn the same face toward the sun, for the same reason that our moon turns the same face toward the earth.

Since one of the foci of the ellipsoid, and the center of gravity of the mass, have both been displaced toward the sun, we may suppose the center of gravity

always to coincide with this focus, as was the case when the figure was spherical.

If, now, we change our supposition as to the form of the orbit described about the sun, and suppose it to be an ellipse of great eccentricity, and that the atmospheric mass is approaching the perihelion of its orbit, it is evident that, on account of the diminishing distance from the sun, his tidal disturbing force is increased, and that the previous equilibrium, between this force and the attraction of the atmospheric mass, can no longer exist.

A new equilibrium must be established by a farther change of the ellipsoidal figure, which must become more eccentric, the focus nearest the sun and the center of gravity of the atmospheric mass retreating together toward the sun more than they had previously done. With each change of distance from the sun, the figure of equilibrium for the atmospheric mass would have to be constantly renewed. It was undoubtedly the investigation of such figures of equilibrium, actually observed with regard to several comets, that enabled Professor Peirce to determine the mass of an average comet. There can be no doubt at all of its probable accuracy. Indeed, would not the atmospheric mass, which we have been supposing to revolve around the sun in a very eccentric orbit, present all the phenomena of a comet?

Among the phenomena of comets noticed by Professor Young is the diminution of the comet's head as it approaches perihelion, and its increase in passing away from this point. It has been shown in No. 103, *Astronomy and Astro-Physics*, that the radius of the spherical head is the distance from the nucleus, or center of gravity, to the surface of the comet nearest to the sun; and that this distance is constantly decreasing as the comet approaches the sun, and necessarily increases on its retreating from perihelion. So that the cause of this phenomenon is fully explained by the tidal theory of the forms of comets.

The cause of multiple tails of some large comets may perhaps be found in the necessary change of eccentricity of the comet's figure of equilibrium as it approaches perihelion, or retreats from it. It is evident, on this theory, that when the tail is first formed the eccentricity must have increased from less than unity, while the figure was ellipsoidal, to the full value of unity, for a paraboloidal figure. But, as the comet approaches the sun still nearer, the focus and center of gravity must still retreat toward the sun. So that the eccentricity will be greater than unity, or the figure of equilibrium will become a hyperboloid. Moreover, the interior strata of the comet's figure may, both in the case of the parabolic form and the hyperbolic, have each its own eccentricity, or separate center of gravity. The nucleus must therefore be divided, as it is sometimes seen to be, especially in the great comet of 1882. These separate foci of the several strata of the comet, one within the other, would produce different divergencies of the hyperbolic branches especially, and thus account for the differently diverging tails of a great comet.

In Art. 727 of Professor Young's work, he gives a fine cut of the "head of Donati's comet, October 5, 1858 (Bond)," showing the way in which, at that date, about five days after perihelion passage, it threw off "jets and streamers of light," "more or less symmetrical envelopes," which followed each other at intervals of some hours.

These phenomena may perhaps be explained by the fact that, as the head of the comet grew smaller, on approaching perihelion, with the same mass at its general center of gravity, the pressure from the greater attraction toward the center of the head, due to the diminished distance from this center of gravity, would be greatly increased, and the elastic strata of gas would have to yield to this pressure. On retreating from perihelion, the head increases its radius, and the attraction toward the center of gravity, and consequent pressure on the elastic strata within, must diminish. These compressed strata of elastic gas therefore naturally push their way outward toward the surface of the comet's head, where the relief of pressure had taken place. On retreating farther from the sun, other such remittances of pressure occur, and new envelopes rise symmetrically toward the sun. Thus these phenomena seem to derive an easy explanation from the tidal theory of the forms of comets and have received no explanation from any other source.

Let us now consider the constitution of comets consisting of "pin heads several hundred feet apart, each particle carrying with it an envelope of gas, largely hydrocarbon." Or as Professor Young elsewhere expresses it, "the head of a comet is a swarm of meteoric stones; though whether these stones are many feet in diameter, or only a few inches, or only a few thousandths of an inch, like particles of dust, no one can say. In fact, it now seems quite likely that the greatest portion of a comet's mass is made up of such particles of solid matter, carrying with them a certain quantity of enveloping gas."

How much "gas, largely hydrocarbon," or otherwise, could be condensed upon one of these "pin heads," or even upon one of the meteoric stones, "many feet in diameter," unless the many feet were many millions of feet? A meteoric stone, one hundred feet in diameter, would be incapable of confining by its gravitating power, its mass, any considerable amount of gas; and the pin heads hardly any at all. If the great mass of the comet itself were chiefly gaseous, then a comparatively small number of these stony masses might be embedded in it.

But what would be their position in the cometary mass? Clearly, on account of their superior density, at the very center of gravity where the nucleus is. Not only so, but the attraction of the comet's great mass, nearly 20,000 millions of millions of tons, according to Professor Peirce's calculation, would forbid their remaining several hundred feet apart from each other, and would aggregate them all, whether "pin heads" or larger, into one compact solid mass at the nucleus or center of gravity. It would be quite impossible for any loose, scattered solids, large or small, distant from each other several hundred feet, to constitute a mass any way comparable to that computed by the late Professor Benjamin Peirce, one of our first mathematicians and astronomers. It would require an enormous repulsive force, such as we see nowhere in nature, except in the elastic force of a gas, to prevent these

solids from rushing down toward, and adhering as closely as possible to, the comet's center of gravity. But the elastic force of the gaseous comet would not prevent this rushing inward of the solids, on account of their greater density.

These considerations are probably sufficient to justify the rejection, in all its forms, of Professor Newton's "sand bank," or "gravel bank," or "meteoric stone" theory of a comet. But, says Professor Young, "this hypothesis derives its chief probability from the modern discovery of the close relationship between meteors and comets." The close relationship between comets and meteors, that is, shooting stars, so called, and meteoric swarms, like those of the Leonids, the Perseids, the Andromedes, and other similar meteoric showers, is freely admitted as conclusively proved. But what evidence is there that the phenomena of the fall of meteor stones or meteorites, as distinguished from meteors, has any such relationship with comets?

Professor Ball, the Astronomer Royal of Ireland, has closely considered this question. He shows that while the meteors, or shooting stars, have generally a very swift motion, passing out of sight in from half a second of time to nearly one second, the meteorites, from which the stony masses are derived, frequently remain in view for a minute or more, having thus a velocity about one-sixtieth of those of cometary meteors, if at the same distance from us. He points out other differences; but the most important is that, during even the greatest shower of meteors, like the great November showers of the Leonids, while the meteors seem to fall by the million, and for hours, like flakes in a snow storm, yet nothing solid has been found to fall to the earth's surface at such times; "with one exception," says Professor Young, in the case of the Mazapil meteorite. The account of this by Professor Young is as follows:

"As has been said, during these showers" (of meteors proper), "no sound is heard, no sensible heat perceived, nor do any masses reach the ground; with one exception, however, that on November 27, 1886, a piece of meteoric iron, mentioned in the list given in Article 758, fell at Mazapil, in Northern Mexico, during the shower of Andromedes which occurred that evening. Whether the coincidence is accidental or not, it is interesting. Many high authorities speak confidently of this particular iron meteor as being really a piece of Biela's comet itself."

But we may reasonably ask, on what grounds do these "high authorities" speak so confidently? Professor Newton tells us that meteoric stones fall nearly or quite every day on some part of the earth. Hence it would not be unreasonable to expect one at Mazapil, or elsewhere, on November 27, 1886, whether the Andromedes were then bombarding our atmosphere or not. But why should only one of the great number of Andromede meteors of 1886 reach the earth, and no other of these, nor any of the millions from the Leonids, the Perseids, and other swarms be found to reach the earth? Clearly the Mazapil meteorite has only an accidental coincidence with the Andromede meteors.

The perfect transparency of a comet, through many thousands or millions of miles of its volume, tells us that it is a very rare gas. In Article 720, Professor Young states, "This estimation of the density of a comet is borne out by the fact that small stars can be seen through the head of a comet 100,000 miles in diameter, and even very near its nucleus, with hardly any perceptible diminution of their luster." Other astronomers have frequently observed the passage of the central portion of the comet's head at or near the nucleus, over a small star without any sensible loss of the star's light. From such facts we can only infer that even the densest part of a comet is a very rare, transparent gas.

Observations of comets with the polariscope prove that nearly all their light is the sun's light reflected by a rare gas. Observations with the spectroscope seem to show that a small portion of their light, when sufficiently near the sun, is somehow excited within the comet itself, but that the substance of the comet is largely if not "wholly gaseous, chiefly hydrocarbon."

If the comets were self-luminous, or largely so with only the addition of some sunlight, then they should be easily visible at all distances. They could not escape the reach of the telescope at their aphelions. But, instead of this being the case, they are only visible when comparatively near the sun and the earth. Their brightness at various distances from us and from the sun follows the same law of increase or diminution as that of the non-luminous planets. Professor Young mentions some slight exceptions to this law in the brightness of certain comets; but perhaps this may be sufficiently accounted for by the irregular transparency of our own atmosphere. All astronomers know that there are times when no clouds are apparent, and yet there is no good seeing with the telescope, on account of the condition of the upper strata of our atmosphere. On the other hand, even when there is a light mist, there may be good seeing and sharp definition in the telescope.

From the ascertained mass of an average comet, and from its transparency, the "sand bank" theory of the constitution of comets, proposed by Professor Newton, of Yale, must be rejected. There is no close relationship between comets and meteorites, or meteoric stones. These latter can be explained, with great probability, as having a quite different origin from the meteoric ring systems which produce the swarms of gaseous meteors, the Leonids and others. In rejecting Professor Newton's theory of comets, I should regret saying anything that could detract from the great merit of his investigations relating to the great November showers of meteors, the Leonids, which investigations prepared the way for computing the orbit of this meteoric ring, and thence of its connection with a comet pursuing the same orbit.—*Astronomy and Astro-Physics*.

THE MOUNT JOY METEORITE.

By EDWIN E. HOWELL.

THE accompanying cut gives a good idea of the form of the third largest meteorite found in the United States, and the largest east of the Mississippi River.

It was found in November, 1887, on or about the 10th of the month, by Jacob Snyder, about a foot below the surface, while digging to plant an apple tree near his house, five miles to the southeast of Gettysburg, in the

township of Mt. Joy, Adams Co., Pa. It was supposed by the finder and his friends to indicate the near presence of an iron mine, and considerable prospecting was done to locate it. The meteorite was placed on some timbers in the open air, where it remained until the summer of 1891, before it was seen by any one who surmised its true character.

Professor F. W. Clarke induced Mr. Snyder to send it to the National Museum for inspection, but was finally unable to secure it, as Mr. Snyder was unwilling to part with it for a price which the museum felt justified in paying. I therefore purchased it from Mr. Snyder on August 15, 1891. The three largest dimensions of the meteorite are 11, 24, and 38½ inches and it weighed on the museum scales 847 lb. Professor Clarke had a few ounces taken off for examination; with this exception and the sealing of decomposed crust, from the outside, the mass still remains as it was found.

Professor Clarke has kindly furnished me with the following analysis, made by Mr. L. G. Eakins in the laboratory of the United States Geological Survey.

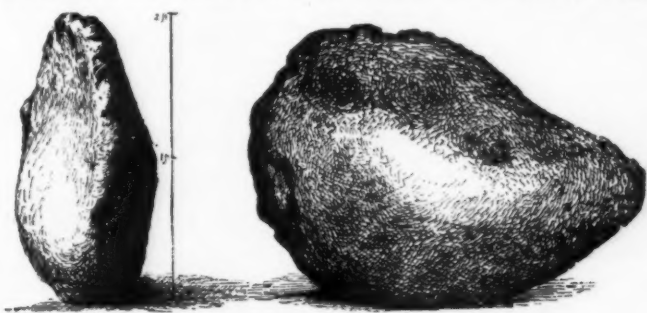
Professor Clarke did not succeed in developing the Widmanstätten figures satisfactorily, and the small amount of nickel shown by the analysis would indicate a poor etching iron; when larger surfaces are available, we shall doubtless obtain better results.

Fe	93.80
Ni	4.81
Co	0.51
Cu	0.005
P	0.19
S	0.01
	99.325

No idea can be formed of the length of time the meteorite had lain in the ground and very little of the amount of surface decomposition it has undergone; sufficient, however, to remove all the finer pittings, leaving a comparatively smooth surface.

Having been much interested in Mr. Davison's examination of the magnetic properties of the Welland meteorite, and thinking that this line of investigation in other meteorites might lead to interesting results, I requested Mr. Marcus Baker, of the United States Geological Survey, to make an examination of the meteorite, which he kindly consented to do.

The result of this examination is to show that the meteorite, as a whole, acts as a mass of soft iron, gaining polarity under the inductive action of the earth. The lower portion on the north side became a north-



THE MOUNT JOY METEORITE.

seeking pole, while the upper part became a south-seeking pole; a pretty distinct neutral line was shown, inclined to the horizon at an angle (20°-25°) which is approximately the complement of the local inclination of the dipping needle. This induced polarity shifted with each change in the position of the whole mass, and in general this shifting of the poles took place promptly, though not always at once. Mr. Baker also states that his observations suggested the probable existence of an unequal distribution of permanent magnetism, but this matter requires further investigation.—*Amer. Jour. of Science.*

RELIABLE REMEDIES AGAINST INSECT PESTS.*

AMONG the most important of them is the spraying of arsenites, that is, with chemical compounds containing arsenic, such as Paris green for foliage-eating insects and kerosene emulsion for such insects as live by suction. This latter is an emulsion made of soap suds and coal oil. Pure coal oil or kerosene is injurious to vegetation; therefore, before it can be sprayed on vegetation, it must be diluted; but coal oil being so like an oil in nature, will not mix with water. Soap suds, however, will mix with the coal oil and also with water; therefore, this emulsion, when diluted, can be used upon vegetation without doing the same injury that pure kerosene would. This is a very valuable discovery for many forms, as the scale insects, which could not be injured by the usual methods, can now be easily destroyed.

Another remedy for these insects, which we have not tried in Canada so far, but which is very successfully used in California, is known as the "gas" treatment. This is a method by which the tree to be treated is inclosed in a tent and then the whole tree is subjected to the fumes of hydrocyanic acid. There is no doubt that, but for the discovery of these methods of treating scale insects and the insecticides, kerosene emulsion, gas, resin, etc., the cultivation of all citrus fruits, such as oranges and lemons, would to-day be quite impossible, both in Florida and California.

Another discovery of great importance in this study was the invention of a proper nozzle. There is, perhaps, nothing that leads so much to failure in the treatment of injurious insects as improper nozzles, and the improper use of the name Cyclone nozzle. The latter is a small instrument invented at Washington under the direction of the United States entomologist, and has the special feature that the fluid is forced into

it in such a manner that it strikes the opposite side with force, and, being driven through a very small central orifice, it does absolutely break up into a spray.

The true Cyclone nozzle or Riley nozzle is made at Washington. A very important modification of the Cyclone nozzle was made by a Frenchman named Vermorel, by the addition of a little needle which is forced through the orifice by means of a spring attached to the handle of the instrument. Any small obstruction which may have stopped up the orifice of the nozzle is easily removed by simply pressing the spring. This, to one who is used to working with spray nozzles, will at once be recognized as a very great advantage, for there is nothing so annoying, when you have got all your apparatus ready and in working order, as to have to stop, take it down, unscrew the nozzle to clean it out, and set to work again. Although so small, and producing such a fine spray, the use of these nozzles is applicable to even large trees. By mounting this very small nozzle—which in some forms does not measure more than half an inch in diameter across the front, and in which the orifice is only a tiny pin hole in the middle—on a very light rubber tube, such as is used here for the gas pipe, and attaching that to a light pole, such as a bamboo fishing rod, you can raise it to any height you require in practical work. You can spray very easily all over trees thirty or even forty and fifty feet high, by tying a small tube to a light pole in the way described, and by that means raising the nozzle to the required height. The liquid having been reduced to a very fine spray, does not go very far from the nozzle. It is, therefore, necessary to spray the trees on the side from which the wind blows, and it will be sometimes necessary to go through an orchard and spray the trees twice, so as to get them thoroughly sprayed.

INJURIOUS INSECTS OF THE SEASON.

The eye-spotted bud moth passes the winter upon the twigs of fruit trees as a half-grown caterpillar. There is only one brood in the year, of which the eggs are laid in June. These hatch soon after, and produce small brown caterpillars, which, during the remainder of the year, feed on the leaves of apple and other trees beneath a silken covering, growing very slowly, the size not exceeding one-quarter inch in length. About October they leave the leaves, and spin small silken cocoons or winter shelters upon the twigs. In these shelters they remain all winter, but come forth in the early spring and attack the buds, and seem to prefer those which contain flower buds. They also frequently bore down the center of the twigs and destroy them.

so that whole clusters of blossoms are destroyed at once. When that is done they go to another twig, so that one small insect can do a great deal of harm.

THE CANKER WORM.

The next insect of which I will speak is the canker worm, which, although not generally abundant in Canada, has for some years destroyed, in the Maritime Provinces, a large proportion of the fruit which might have been grown there, simply because, when it increases largely in numbers, as it did there, it frequently strips the trees entirely of their leaves and the fruit cannot mature. During last season a very interesting outbreak of this same insect occurred in Winnipeg, where it was reported to have destroyed several shade trees, by stripping them entirely of their leaves. The trees grown there as shade trees are the ash-leaved maple, or the Manitoba maple, as it is sometimes called (*Acer negundo*). It appears this tree is very susceptible to injury if its leaves are destroyed.

Mr. Fonseca, of Winnipeg, wrote to me that many of the best shade trees in the part of that city where he lives had been destroyed by this insect. Now there are very few insects which can be so easily destroyed, and at so small expenditure, twelve or fifteen dollars for a spraying pump, and perhaps two or three dollars more for labor, and the materials used would entirely free the shade trees in the streets of Winnipeg of this troublesome enemy. I think it will be a great pity if the city authorities do not take steps next spring, when the young caterpillars hatch, to have them all destroyed, by spraying the trees with Paris green in water. One pound to 300 gallons of water would be sufficient, and it is of importance, because the trees are so few there.

In Vancouver Island two years ago the oak trees all around Victoria were stripped by another caterpillar of the same family. These caterpillars are known, from their manner of walking, as geometers or loopers. They stripped the trees entirely of every vestige of foliage. These also could have been destroyed just as easily as those I have spoken of above.

The canker worm attacks many kinds of trees, but it is particularly injurious to apple trees. Along the Montreal road, near Ottawa, during the past season it occurred in such large numbers in some orchards that many of the trees appeared, as is often stated, as if they had been burned over with fire. With the canker worms were also found two kinds of leaf-rollers, and the caterpillar of the eye-spotted bud moth. These caterpillars are hidden from sight. They roll up or gather together one or more of the leaves of an apple tree and then feed from within on the leaves, so inclosed. The same poison, Paris green, destroys them all. An interesting and new attack, studied last

season, was that of a *coleophora* or case bearer, so called from the little cigar-shaped case which it carries about with it, and inside which it lives while in the caterpillar state. It makes a small hole through the surface of the leaf and eats out the green cellular matter between the surfaces. It has proved rather difficult to fight because of this habit; but after extensive experiment it was found that it could be most successfully combated by throwing a Paris green spray on the foliage.

A SUCCESSFUL REMEDY FOR PEA WEEVIL.

The remedy used successfully was this: The pease were poured out into a large receptacle half filled with hot water—wash tubs were used generally: cold water, which had been got ready beforehand, was then thrown over them and the tub filled to the top. Directly the pease were thoroughly wetted the cold water was poured in, and they were then left to soak for twenty-four hours, and the beetles were all destroyed.

RECIPE FOR PREPARING KEROSENE EMULSION.

What are the proportions used in making it? It is made by making a mechanical mixture of kerosene and soap suds in the proportion of two of kerosene to one of soap suds. These two materials are worked together with a force pump for about five minutes, when a thick, creamy batter is formed, and this can be reduced again to any weakness or state of dilution with cold water. Paris green is about the cheapest good remedy for insects where it can be applied; but it cannot be applied with all insects, and this kerosene emulsion covers all classes. Directly it touches the insect it spreads all over its body. Insects, as most people know, do not breathe through their mouths. They breathe through little pores which are situated along their sides, and any oily material, like kerosene, when it touches their bodies, suffocates them, by spreading over the body and stopping up the breathing pores.

The proportions are as follows: One half of a pound of ordinary soap is dissolved by boiling in one gallon of water, and when it is boiling hot it is poured into two gallons of coal oil (kerosene), and churned with a syringe or a force pump, and in about five minutes it comes thick and creamy; when this cools it consolidates into a jelly-like mass, which can be diluted with cold water. Kerosene emulsion has been found particularly useful during the past season for the treatment of one of the worst enemies we have in the orchard.

THE OYSTER SHELL BARK LOUSE.

It attacks many kinds of trees and shrubs, but is particularly troublesome on apple trees and black currant bushes. I have also found it on mountain ash, birch and ash trees. At this time of the year it may be found on trees in the shape of a small elongated scale like a miniature oyster shell. This is really the dried-up body of the female insect, beneath which will be found a large number of white eggs. In the month of May the young emerge from beneath the scales in countless numbers. They are minute creatures, hardly visible to the naked eye. They then climb up to the young wood, where the bark is tender, and through it they insert their little tube-like beaks, and never move again, but remain fixed by their beaks, sucking the sap out of the tree. They gradually secrete a waxy fluid, which covers and protects them. This covering resembles in appearance an oyster shell. There are probably more orchards killed and there is more loss to fruit from this one cause than from all other causes put together. Farmers and fruit growers frequently do not fight it, because they do not recognize it as an enemy that can do them harm. But if they do recognize it, and apply kerosene emulsion, they can destroy it as effectually as all other insects.

The emulsion can be sprayed over the trees at the time the young are hatching, when all will be killed. When reducing the emulsion for this purpose, it can be diluted with nine times its volume of water.

THE PEAR TREE SLUG.

The pear tree slug is another insect which, during the past year, developed in injurious numbers. It is a slimy creature, that lives on cherry and pear leaves, and should be treated at once when observed with a weak Paris green spray of 1 lb. of the poison to 300 gallons of water.

In the Northwest Territories, during the past year, a native insect has occurred in very large and injurious numbers. It is a conspicuous red and black beetle, not quite so large as the Colorado potato beetle, which is found in this part of the country, but it feeds on plants of the cress family, such as turnips, radishes and cabbages.

POTATO ROT AND ITS REMEDY.

The potato rot causes a great diminution of the crop every year throughout the length and breadth of Canada—perhaps, year in and year out, 50 per cent. of the whole crop grown. The life history of the fungus which causes this disease has been worked out and is well understood. It passes the winter inside the potato tuber. When growth begins in spring it germinates, and throws out its vegetative system, and creeps up through the tissues of the potato stem, and during July and August manifests itself as a white, frosty growth or mildew on the potato tops; this is followed by the leaves turning brown in spots, and giving the appearance known as potato rust. At this time spores or seed-like bodies are formed, which drop from the potato tops to the soil beneath and are washed by rain down to the forming tubers below the surface; here they germinate and penetrate the tissues and eventually destroy the potato. Now, if one of the known fungicidal mixtures be sprayed over the potato tops as they grow in the field, beginning at the time the white, frosty appearance first shows itself, the spores will be destroyed and the crops saved.

The spraying will require to be repeated at least twice. The mixture which has given the best results is the Bordeaux mixture. This is made as follows: Dissolve six pounds of copper sulphate in ten gallons of water; throw this into a barrel which will hold 45 gallons. In another tub slake four pounds of perfectly fresh lime in six gallons of water. When all the lime is slaked, pour it slowly through a strainer into the copper solution; a coarse gunny sack tied over the

* Abstract from the evidence of Mr. James Fletcher, entomologist and biologist, before the select standing committee of the Canadian House of Commons, on agriculture and colonization. Session of 1892.

head of the barrel answers well for this purpose. Afterward fill the barrel up to the top with water, which will make 45 gallons; stir thoroughly and all is ready for use. It is best to use powdered copper sulphate, and the lime must be quite fresh.

Made as above, the mixture costs about one cent a gallon, and a barrel will be sufficient to spray a very large area. This last point of course will be regulated by the kind of nozzle used.

This remedy may be used at the same time and with the one application as Paris green, which all good farmers now know that they must use to protect their potato crop from the Colorado potato beetle; one-fourth of Paris green in the above quantity is sufficient.

You often find potatoes put away that appear quite sound, but are not sound? Yes; the disease is hidden inside the potato. Directly the spore reaches the growing tuber it germinates, and shoots out microscopical tubes, which penetrate the tissues.

CYCADS AT KEW.

THE collection of cycadeous plants in cultivation at Kew stands unrivaled, both in regard to the number of species represented and the size of the specimens

besides the two common ones. There are few plants more interesting and ornamental than the anomalous *Bowenia spectabilis*, and in the whole range of garden plants we have nothing nobler than *Encephalartos Altensteinii*, when largely developed, as it is at Kew.

The cones of many cycads are highly ornamental, both in form and color, while some are of great size. *Encephalartos villosus* produces cones eighteen inches high and six inches wide, formed like a pineapple, and colored bright yellow on the fleshy scales, through which the large nut-like seeds, colored rich red, are finally partially exposed. The collection of cones sent from Kew to illustrate Mr. Carruthers' lecture before the Royal Horticultural Society recently excited as much admiration as surprise among cultivators, many of whom, forgetting how many had been illustrated in our own columns, could not understand how such things could be in English gardens, and they not know of them.

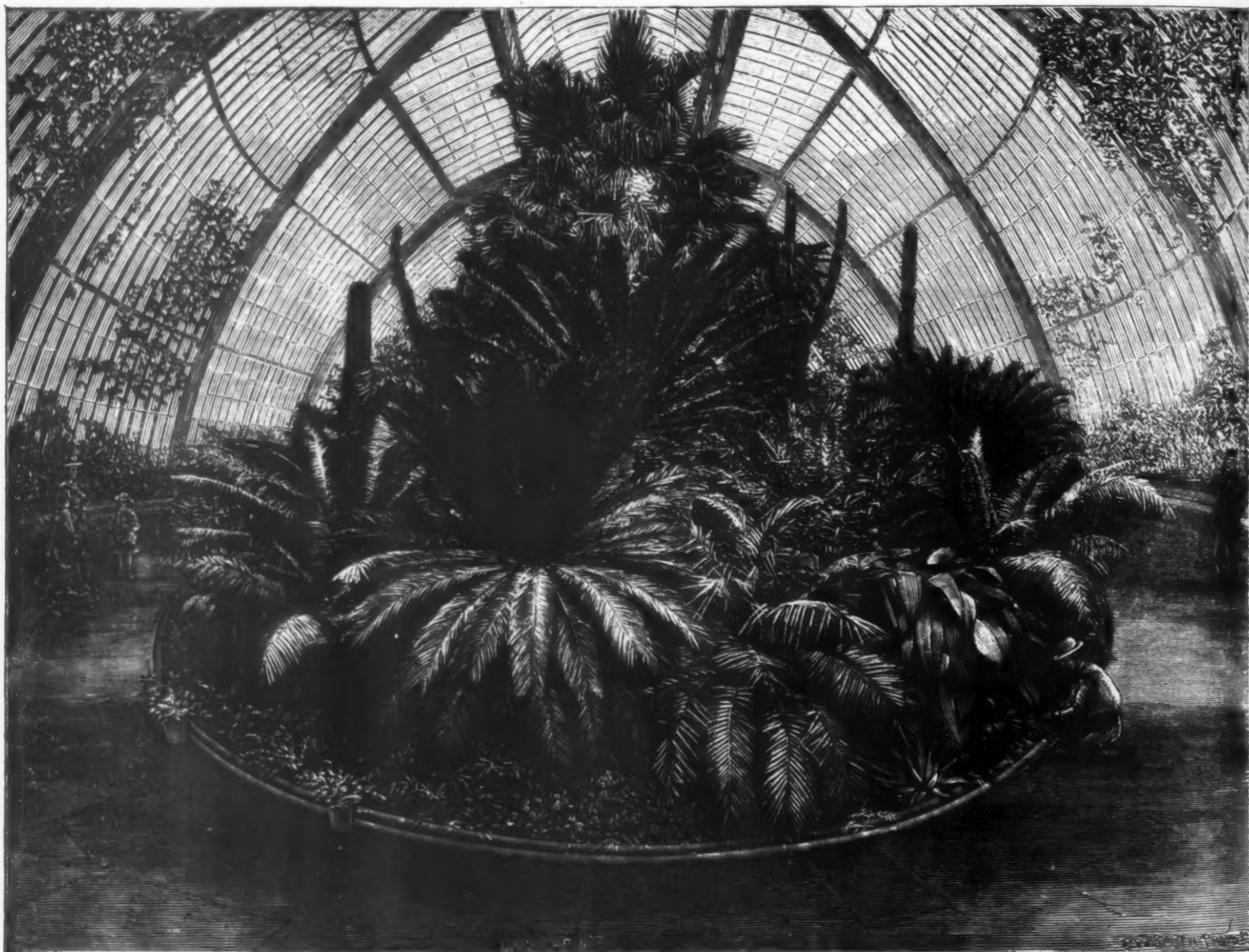
Although cycads are rare in the garden, many of them are old introductions. According to the Kew records of J. Smith, *Cycas circinalis* was in cultivation there in 1700 and it is at least a hundred years since *C. revoluta* was introduced. The first plant of *Encephalartos Caffers* sent by Masson to Kew in 1775, and which Sir Joseph Banks saw in cone in 1819, is, we learn, alive and well at Kew still, as also are the six plants of

a keen admirer of cycads generally. Some of Mr. Bull's plants have from time to time figured in our columns; but, for all that, the gardening public is hardly aware of the grand subjects at their disposal. It is far otherwise on the Continent. There are good collections of these plants in the Botanical Gardens of St. Petersburg, Hanover, and Berlin. Visitors to Ghent, especially at the quinquennials, are generally struck with the magnificence of these plants. Many of them are highly ornamental, even when small, as was illustrated recently by Messrs. Shuttleworth, but we were surprised to learn from Mr. Wills that the plants are not suitable for room decoration. Mr. Carruthers' lecture, mention of which is made in another column, was well illustrated by foliage and cones from Kew. It was an admirable summary of many of the chief points of interest in this most interesting group.—*The Gardeners' Chronicle*.

THE OLD STONE MILL AT NEWPORT.*

J. P. MACLEAN.

THE quadri-centenary of the landing of Columbus at one of the West India Islands has caused renewed attention to be given to what are claimed to be, with more or less probability, proof of the pre-Columbian



CYCADS IN THE PALM HOUSE, ROYAL GARDENS, KEW.

generally. The group represented in our illustration is made up of huge specimens of *Encephalartos*, *Dioon*, *Cycas*, *Macrozamia*, and *Zamia*. These, however, are only a portion of the cycads contained in the palm house, very large specimens occurring frequently among the several large groups into which the giants of the house are now divided. *Cycas circinalis*, nine feet high, and branched, is planted out in one of the beds among great palms and musas; a male plant of *C. revoluta*, with a magnificent rosette of leaves, is conspicuous in the north end of the house, and last year attracted considerable attention while bearing a cone sixteen inches long. Cycads generally fruit well at Kew, and there is now in Museum No. 1 a large collection of the cones of these plants, most of which have been produced by the Kew plants.

The ornamental character of almost all cycads is made abundantly evident by those in cultivation at Kew. For large stoves or warm conservatories many of them are at least as well adapted as the best of palms and tree ferns. A large house planted with the best of these three orders might be made a magnificent picture, full of interest and charm for the scientific as well as for the everyday person. The two which may be called fairly well known garden plants, viz., *Cycas revoluta* and *C. circinalis*, have not a few rivals in decorative value, such being *Zamia muricata*, *Z. Lindenii*, *Encephalartos Hildebrandtii*, *E. Frederici-Guilelmi*, *Ceratozamia Mexicana*, *Macrozamia Hopei* and *M. Macleanii*. There are also some beautiful species of *Cycas*

the same genus which were received from the Cape in 1849. James Bowie sent *E. horridus* to Kew in 1823, and his plants are thriving in the palm house now.

The recent additions are *Macrozamia Moorei*, received in 1882 from Australia, and several other species of this genus, among them being *M. Dyeri*, named in compliment to the director of Kew, who has long paid special attention to cycads, with a view to writing a monograph of them, having accumulated splendid material for that purpose. *Zamia Houtteana*, a broad-leaved distinct species, and *Dioon spinulosum*, a handsome plant than *D. edule*, are other striking cycads of recent discovery, and now represented by living examples at Kew.

The cultural requirements of cycads formed the subject of an interesting and useful article published in the *Gardeners' Chronicle* on March 9, 1889, p. 298, from the pen of Mr. Frank Ross, whose experience at Kew and at Pendell Court made him acquainted with the requirements of these plants.

Importations of the stems of cycads are not unknown to London auction rooms and they sell cheaply enough. There need not be any fear as to the health of these imported plants; at any rate, those obtained in this way for Kew have, as we are informed, proved successful.

The most extensive collection of cycads in this country is in the possession of Mr. Bull, at Chelsea, who has introduced not a few of the best of them, and who has long since proved himself a successful grower and

discovery of America. The advocates of the discovery of our continent by the Norsemen again put in evidence the old stone mill at Newport, and, like many of their predecessors, claim that the building was erected by Scandinavian immigrants to this land five hundred years before Columbus was born. With the question of the discovery of the new world by Norsemen, I do not propose to meddle at present. My only object is to show that, as a piece of testimony in favor of such discovery, the old mill is worthless.

If the tower was standing when Rhode Island was first settled, it would have been a work of so great wonder as to have attracted general attention. Newport was founded in 1639, and in none of the early documents is there any mention of the old mill. There was no tradition concerning it among the people, but it was universally referred to as a windmill, showing for what purpose it had been used. It is positively known that the structure, during the eighteenth century, served both for a mill and a powder house. It is first distinctly mentioned in the will of Governor Benedict Arnold, of Newport, in which it is called "my stone built windmill." Had it been an ancient monument, Dr. Danforth, in 1680, or Cotton Mather, in 1712, would not have failed to mention it.

The first house in Newport was built by Nicholas Easton; but he makes no mention of the old stone mill. In 1663, Peter Easton wrote, "This year we

* *American Antiquarian*, Chicago, September.

build the first windmill," and, in 1675, he wrote, "A storm blew down our windmill."

Benedict Arnold must have been a very popular man in Rhode Island, for he was several times governor, the last time from 1677 to 1678. He came from Providence to Newport in 1653. He built a home upon a lot of sixteen acres, the eastern part of which includes the mill. Governor Arnold died in 1678, aged sixty-three years. His will is dated December 20, 1677, in which he says: "My body I desire and appoint to be buried at ye northeast corner of a parcel of ground containing three rods square, being of, and lying in my land, in or near the line or path from my dwelling house, leading to my stone built windmill, in ye town of Newport above mentioned." Edward Pelham, son-in-law of Governor Benedict, in his will dated May 21, 1741, in a bequest to his daughter, Hermoine, mentions: "Also one other piece or parcel of land situated, lying, and being in Newport aforesaid, containing eight acres or thereabouts, with an old stone windmill thereon standing, and being and commonly called and known by the name of the mill field, or upper field." In 1834, Joseph Mumford, then being eighty years old, stated that his father was born in 1699, and always spoke of the building as a powder mill, and he himself remembered that in his boyhood, or about 1760, it was used as a hay mow.

In the foregoing citations it will be observed that Governor Arnold does not call the building an "old" mill, but my "stone built windmill." At the time that Pelham made his will, the structure had been standing not less than sixty-five years, and hence he very properly designates it as "an old stone windmill."

Besides the documentary testimony there is the evidence derived from the mill itself. The mortar is composed of shells, sand, and gravel. In the year 1848, some mortar taken from an old stone house in Spring Street, built by Henry Bull, in 1639, some from the tomb of Governor Arnold, and some from other buildings was compared with the mortar of the old mill, and found to be identical in quality and character.

The poet has very fittingly said of the attempt to Norseize the old Newport mill:

"Alas! the antiquarian dream is o'er;
Thou art an old stone windmill—nothing more."

[Continued from SUPPLEMENT, No. 883, page 14164.]

RECENT CONTRIBUTIONS TO THE CHEMISTRY AND BACTERIOLOGY OF THE FERMENTATION INDUSTRIES.

By PERCY F. FRANKLAND, Ph.D., B.Sc. (Lond.), F.R.S., Professor of Chemistry in St. Andrew's University, Dundee.

LECTURE II.—CULTURE MEDIA.

As already pointed out, the most varied materials have been employed for the cultivation of micro-organisms, but while the earlier investigators made exclusive use of liquid media, within recent years solid media have come more and more into vogue. In fact it may be said, without exaggeration, that the great advances which have been made in our knowledge of micro-organisms, during the past ten years, have been mainly due to the introduction of such solid culture media.

It is not that the micro-organisms prefer the solid media to grow in, for as a general rule, on the contrary, they show a preference for the liquid ones. The advantage of the solid media, however, lies in the greater facilities which they afford for obtaining pure cultivations of micro-organisms, and pure cultivations are the key to bacteriological progress, just like pure reagents are indispensable to progress in medical science.

We will turn our attention for a few minutes to this important question of preparing pure cultivations, which confronts us in every investigation connected with micro-organisms.

Pure Cultures with Liquid Media.—(1.) The simplest, although but rarely available method, consists in starting a growth of organisms in a liquid medium, which experience has shown is specially suitable for the particular organism which we desire to obtain in pure culture. When microscopic examination shows that this organism has abundantly multiplied in the medium, we transfer a minute quantity to a fresh portion of the same medium, allow the multiplication to take place there, and then again transfer to a fresh portion of the medium. By repeating this transfer a number of times, it is sometimes possible to so purify the growth that finally only one kind of micro-organism is present.

This principle is really abundantly taken advantage of in a modified form in the fermentation industries.

Thus, in the alcoholic fermentation, the wort is artificially maintained at those temperatures at which it is a good culture medium for yeast, but a bad or indifferent one for such organisms as those of the lactic and acetic fermentations; while sometimes additions are made to the wort which are inimical to these objectionable ferments, but affect the growth of the yeast only slightly or not at all. This is notably the case with sulphurous acid, which has long been used in many breweries for the purpose of excluding foreign fermentations. Again, the practice of keeping alcoholic liquids of low strength, such as beer and light wines, fully charged with carbonic acid gas is another case in point, as in this way the acetic organism is kept in check, and a free field maintained for the yeast.

On the other hand, in the vinegar or acetic fermentation, by maintaining a strongly acid reaction, with abundant aeration, the medium is practically preserved for the undisturbed development of the acetic organism.

In this way, however, absolutely pure cultures are but rarely obtained, and in scientific investigations the method generally only serves as a convenient means of preliminary purification, before employing some of the more exact processes to which I shall presently refer.

In connection with the use of sulphurous acid as a preservative, we may take notice of some recent experiments which have been made by Linossier, with a view to rendering our knowledge of its antiseptic action more precise.

The greatly increased activity of the sulphurous acid, in the presence of the merest traces of free min-

Sulphurous Acid—Toxic Doses per 1000 c. c.

	1 hour.	6 hrs.	24 hrs.	5 days.
	c.c.	c.c.	c.c.	c.c.
Brewers' yeast	200	100	50	—
Yeast (from raisins)	100	30	20	10
" (with 0.25 grm. sulphuric acid)	(40)	(1)	(1)	—
Mycoderma vini	200	100	100	40
Aspergillus niger	50	20	20	—

eral acid, is not only interesting, but might very possibly be of technical value in some cases.

In this connection I may refer to some very interesting results which have recently been obtained by Effront, in the use of mineral acids for the suppression of undesirable fermentations in breweries and distilleries.

Effront found that 100 c. c. of wort were protected from the lactic and butyric fermentations absolutely by 0.025 gramme hydrofluoric acid, 0.200 gramme hydrochloric acid, 0.300 gramme sulphuric acid. And these fermentations were very materially retarded by hydrofluoric acid, 0.002 gramme; hydrochloric acid and sulphuric acid, 0.020 gramme.

If both ferments are simultaneously present, very much smaller doses of hydrofluoric acid are efficient in suppressing them: thus, 0.0008 gramme hydrofluoric acid greatly retards, and almost entirely suppresses, the more dangerous butyric ferments.

Effront further found that such additions of hydrofluoric acid, instead of injuring the diastatic power of malt, were favorable to it. In some cases the use of ammonium and potassium fluorides was preferable to that of the free acid. The pretensions of the method may be gathered from the following experiment:

Three kilogrammes maize were made to yield 10 liters of mash. Using 14 per cent. of malt, there were obtained, without ammonium fluoride, 57.02 alcohol to 100 parts starch; using 7.5 per cent. of malt, there were obtained, without ammonium fluoride, 54.30 alcohol to 100 parts starch; using 14 per cent. of malt, there were obtained, with 0.2 gramme ammonium fluoride, 66.98 alcohol to 100 parts starch; using 7.5 per cent. of malt, there were obtained, with 0.02 gramme ammonium fluoride, 66.07 alcohol to 100 parts starch. The method has been tested on a practical scale in several German distilleries—in some cases apparently with much success—and it would undoubtedly appear to deserve trial.

2. The only reliable method of obtaining pure cultures by means of liquid media is far more complex and troublesome than that which I have described. It is known as the "dilution method," and consists in largely diluting the liquid containing the micro-organisms, and then dividing this diluted material into such a number of small fractions that each of these fractions contains not more than one micro-organism. Such a fraction then forms the starting point for a pure culture of the particular organism.

Although the principle of this second method is obvious enough, and is comprised in these few words, yet its actual execution is in the highest degree laborious and wearisome, success often only being achieved after many abortive attempts.

An idea of the manner in which this method is carried out may be gathered from the following hypothetical case: Suppose that it has been estimated, by microscopic examination, that about 10,000 microbes are present in one cubic centimeter; then dilute 1 to 100 c. c. with sterile liquid, and inoculate 10 tubes each with 1 c. c., each tube will contain about 100 microbes; inoculate 10 tubes each with 0.5 c. c. each tube will contain about 50 microbes; inoculate 10 tubes each with 0.1 c. c., each tube will contain about 10 microbes. Then dilute 1 c. c. to 1,000 c. c., with sterile liquid, and inoculate 10 tubes each with 1 c. c., each tube will contain about 10 microbes; inoculate 10 tubes each with 0.5 c. c., each tube will contain about 5 microbes; inoculate 10 tubes each with 0.1 c. c., each tube will contain about 1 microbe; inoculate 10 tubes each with 0.05 c. c., each tube will contain about 0.5 microbe.

Of the last ten tubes, then, about five only would develop growths, and these would, in all probability, be derived from a single microbe each, and thus be pure cultures.

In the case of large micro-organisms, like yeast, the method is not nearly so troublesome as in the case of bacteria, for it is comparatively easy to estimate with a fair degree of accuracy how many yeast cells are present in a given volume of liquid with the aid of the hematimeter.

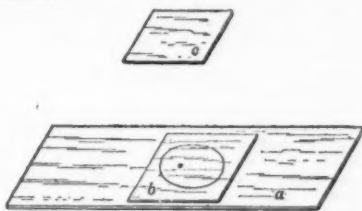


FIG. 7.—HEMATIMETER. (After Jorgensen.)

a, Glass slide on which the perforated glass square, b, is cemented so as to form an extremely shallow circular cell, the depth of which is accurately determined. On the glass bottom of this cell some very small squares of known dimensions are etched. A small drop of the liquid in which the number of yeast cells is to be determined is placed in the cell, and the cover glass, c, placed on the top so as to be in contact with the liquid in the cell. The volume of liquid resting on each of the little squares is thus easily calculated, and by counting the yeast cells visible with the microscope in each square, the number in the particular volume of liquid is determined.

It was in this manner that Hansen, in his classical researches, first obtained cultures of pure yeast (1882). I have more recently employed the method for the isolation of the nitrifying organism, but to this I shall refer again later on.

Solid Culture Media.—Considering, then, what enormous difficulties attach to the preparation of pure cultures by means of liquid media, it may be imagined

how welcome was the introduction, by Koch, of the new methods of culture on solid media, which greatly facilitated the process of purification.

The commonest solid media employed are gelatin-peptone, agar-agar, and potatoes.

I may take this opportunity of stating the precise composition of some of the more important of these solid media:

	Gelatin-peptone.	Agar-agar-peptone.
Lean beef	1 lb.	1 lb.
Gelatin (leaf) ..	100 grms.	Agar-agar 15 grms.
Peptone (dry) ..	10 grms.	10 grms.
Common salt ..	5 grms.	5 grms.
	1,000 c.c. water.	1,000 c.c. water.

The gelatin-peptone is suitable for cultures not requiring more than 23° C. for their incubation; when higher temperatures have to be employed, the agar-agar-peptone must be used, or some other medium which will remain solid at the temperature in question, e. g., potatoes, hard boiled white of egg or coagulated blood serum. The latter was formerly the only medium on which the tubercle bacillus could be cultivated, until it was shown by Noctard and Roux that agar-agar to which about 5 per cent. of glycerin had been added formed an excellent nutritive material for these bacilli, and in fact now the addition of glycerin is almost invariably made for the agar-agar-peptone medium.

Pure cultures may frequently be obtained by simply streaking with a needle bearing the organisms under investigation over the surface of one or other of these solid materials. In so doing each organism is obviously fixed by the solid at the point where it is deposited, and the progeny to which it gives rise by multiplication grows up around it, and these growths, being more or less isolated, are pure, and further pure growths can be obtained by inoculation from them.

[Demonstration of streak growths of various organisms.]

Such solid surfaces of nutrient materials have also been largely employed by myself and others for investigating the micro-organisms of the air, for if such surfaces are exposed to the air, the micro-organisms present in the latter fall upon them in different places, and thus give rise to isolated growths from which pure cultivations can be propagated.

[Demonstration of gelatin plates and slices of potato that had been exposed to air, and on which colonies of aerial micro-organisms had appeared.]

Plate Cultures.—A most important modification and advance upon the process I have just described, and which we also owe to Koch, consists in mixing the organisms with a liquefied jelly, thoroughly distributing them in the fluid mass, and then pouring this mixture out on a cold glass plate, on which it rapidly solidifies; on keeping this sheltered from dust in a moist chamber at a suitable temperature, the organisms multiply and give rise to isolated colonies, as they are generally called, each of which is a pure culture.

[Demonstration of a plate culture with its colonies.]

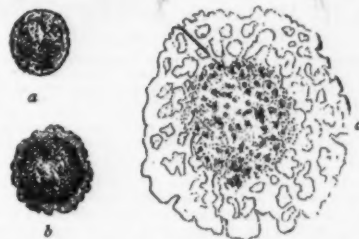


FIG. 8.—COLONIES OF BACILLUS DIFFUSUS* (Percy Frankland) MAGNIFIED ABOUT 100.

a, b, and c represent the different stages of the colony's growth.

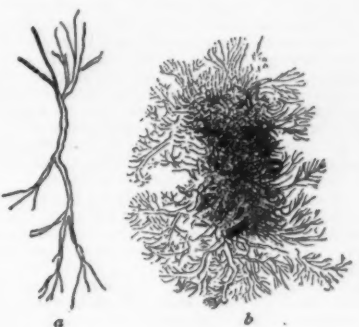


FIG. 9.—COLONIES OF BACILLUS ARBORESCENS† (Percy Frankland) MAGNIFIED ABOUT 100.

a, b, and c represent the different stages of the colony's growth.

* Obtained from soil.

† Obtained from water.

* This was added to half of the 10 liters of the mash obtained.

It is quite impossible to overestimate the benefit which this elegant process has conferred on bacteriological science. Not only does it enable us in many cases to obtain pure cultivations with great facility, but from the appearance of these colonies, when viewed either with the naked eye or more generally with a low power of the microscope, we are often able to recognize the particular organisms with which we have to deal.

The identification of micro-organisms is often a matter of much difficulty, and entails long practice, but from the foregoing figures you will be able to form an idea of the great assistance which is frequently to be derived from a study of the colonies.

Modifications in Gelatin Plate Process.—Although ten years have elapsed since Koch first introduced this process of gelatin plate culture, only trifling modifications—they can hardly be called improvements—have been made in it; indeed, the process is, in many respects, so perfect and simple that it hardly admits of any. The only material modification which occasionally presents special advantages is that introduced by Esmarch, and which consists in producing the gelatin film on the inside of a test tube instead of on the surface of a plate (Fig. 10).

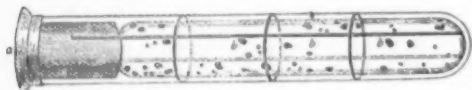


FIG. 10.—ESMARCH TUBE CULTURE WITH COLONIES.

a, India rubber cap covering cotton-wool stopper; b, numerous colonies in the gelatin film; c, ink marks on the outside of the test tube, to facilitate the counting of the colonies.

This modification becomes particularly serviceable in the study of the ordinary fermentation organisms, and what are known as anaerobic forms; for the culture can easily be incubated, in the absence of air, or in an atmosphere of any gas that it may be wished to experiment with (Fig. 11).

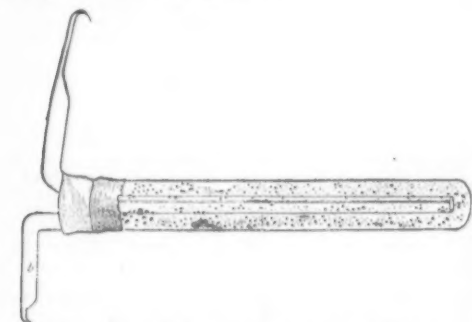


FIG. 11.—ANAEROBIC ESMARCH TUBE CULTURE (Carl Fraenkl).

aa, Glass tube, through which hydrogen or other gas is passed into melted gelatin. b, Exit tube for stream of gas. Both of these tubes are sealed in the blowpipe, after the gas has been passing for about 15 minutes; the melted gelatin is then made to congeal on the inner surface of the test tube, by rotating the latter horizontally in cold water. c, Doubly perforated India rubber stopper, coated outside with paraffin wax. Numerous colonies have appeared in the gelatin film.

This may often serve as a particularly convenient means of identifying fermenting organisms in the presence of others, as the fermenting organisms are always capable of growing in the absence of air, and they betray their presence in the gelatin film, not only by the formation of a visible colony, but by the generation of a bubble of gas, if the gelatin is made with an addition of 1 to 2 per cent. of dextrose.

Instead of using hydrogen to displace air from a culture material, to be used for the growth of an anaerobic organism, the removal of the oxygen may be effected by means of bacterial life itself, as devised by Roux, Salomonsen, and Buchner. For this purpose a small culture tube is fitted in the ordinary way, sterilized and inoculated with the anaerobic organism under examination; it is then placed in a larger tube containing broth which has been infected with *Bacillus subtilis*, or some other organism which rapidly consumes oxygen. This outer tube is then tightly closed with an India rubber stopper, which may be further coated and sealed with paraffin. The oxygen is rapidly removed from the entire closed space by the vegetation of the *Bacillus subtilis* in the outer vessel, thus permitting the growth and development of the anaerobic organism in the inner tube.

Instead of using the culture of *Bacillus subtilis* in the outer tube, it is more convenient to employ a mixture of caustic potash and pyrogallie acid, which, as is well known, rapidly absorbs oxygen. The arrangement is shown in Fig. 12.

Unfortunately, a number of organisms are known which will not thrive on this gelatin medium; some not at all, and others only at temperatures above that of the melting point of the gelatin.

But, even when organisms will not grow on gelatin, the gelatin plates may sometimes still be successfully used for obtaining pure cultures. Thus, supposing we have an organism which will not grow on gelatin mixed with other organisms which do thrive on this medium, we may make use of the following artifice for securing the organism which does not grow on the gelatin.

Plates are poured off the mixture, and, in due course, the organisms which thrive on the gelatin give rise to colonies. Now, the organisms which do not grow on the gelatin must obviously lie in the interspaces between these colonies, and by cutting out some of the interspaces with sterilized instruments, we shall obtain these organisms purified from all those which thrive on the gelatin. This artifice has, indeed, been occasionally most successfully employed. To this we shall have to refer again, in connection with the important organisms which bring about nitrification in the soil.

A special jelly has recently been devised to meet the requirements of some refractory organisms—like those of nitrification—which refuse to grow on gelatin, and which demand a medium free from organic matter. These may be most successfully cultivated on silica

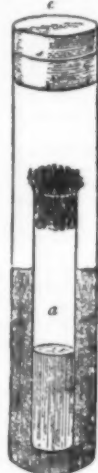


FIG. 12.—ANAEROBIC CULTURE.

a, Ordinary culture tube plugged with cotton wool; b, larger test tube containing mixture of pyrogallie acid and caustic potash; c, India rubber stopper coated with paraffin.

jelly, a preparation which is wholly destitute of organic matter, and in which the gelatinous consistency is secured by means of dialyzed silicic acid. To the sterile solution of dialyzed silicic acid, placed in a sterile glass dish with flat bottom, a sterile solution of the following composition is added:

Ammonium sulphate.....	0.4	grm.
Magnesium sulphate.....	0.05	"
Potassium phosphate.....	0.1	"
Calcium chloride.....	trace.	"
Distilled water.....	100	grm.
Sodium carbonate.....	0.6-0.9	"

The two are thoroughly mixed, after which gelatinization takes place in from five to fifteen minutes. The carbonate of soda may often be advantageously replaced by magnesium carbonate, but the medium is then not transparent.

But even when an organism grows on gelatin it is not always possible to isolate it by the ordinary process of plate culture, for it may be mixed with other organisms which have the property of peptonizing or liquefying the gelatin to such an extent that the organism in question may be crowded out, and the whole plate may have become liquid before it has had time to give rise to a colony of recognizable dimensions. This is a point which must be constantly kept in view by all engaged in isolating particular micro-organisms, and frequently necessitates the use of special methods adapted to the special habits and characters of the organisms under investigation. I may take two examples to illustrate how such difficulties have been overcome in specific cases.

The first case is that of the method which has been devised for identifying the presence of the typhoid bacilli in potable water. These bacilli in such waters are invariably associated with a large number of other forms which grow freely on gelatin and often cause its liquefaction, and as the colonies of the typhoid bacillus grow comparatively slowly, and are but little characteristic, it is quite hopeless to endeavor to detect them in an ordinary plate cultivation of a sample of water. Under these circumstances, advantage has been taken of the ascertained fact that this typhoid bacillus is particularly insusceptible to doses of carbolic acid.

In order to apply this peculiarity to the detection of the typhoid bacilli, a number of tubes, each containing 10 c. c. of neutral bouillon, are prepared, and to these are then added from 0.1, 0.2, and 0.3 c. c. of the following solution:

Carbolic acid.....	5	grms.
Hydrochloric acid.....	4	"
Distilled water.....	100	"

These tubes are then inoculated with 1 to 10 drops of the water under examination, after which they are placed for twenty-four hours in the incubator at 37° C.

Under these circumstances most of the microbes present in natural waters are destroyed, while the typhoid bacilli multiply abundantly. From these broth tubes, after incubation, gelatin plates are now poured in the ordinary way. The colonies of the typhoid bacilli, should they be present, can easily be discovered, and their identity proved by confirmatory tests, such as their characteristic growth on potatoes, presence of flagella, etc.

The second case, which illustrates in the most instructive manner how the special properties of a microbe may be taken advantage of for its isolation, is that which was resorted to with such signal success by Kitasato for the bacillus of tetanus. This organism, as present in the pus of a wound which has caused tetanus, is always surrounded by a number of other forms. The first step in the purification of the bacillus consists in taking advantage of the fact that it is anaerobic, i. e., that it grows in the absence of oxygen. To this end the pus is cultivated in an atmosphere of hydrogen; under these circumstances it grows freely, but so do also some of the other organisms with which it is mixed. Kitasato, however, observed that there was an important difference between the tetanus bacillus and these other organisms; for he found that the tetanus bacillus developed spores at a much earlier period than any of the microbes with which it was associated. Now the possibility of arriving at a successful issue was at once apparent. Taking advantage of the well-known fact that spores are capable of resisting for some time high temperatures which are rapidly fatal to

the vegetative or fully developed microbes, he proceeded to heat the cultures as soon as these tetanus spores had made their appearance, and by maintaining the temperature at 80° C. for some time, all the organisms excepting the spores alone were destroyed, and inasmuch as only the tetanus bacilli had formed spores, a pure culture was thus obtained.

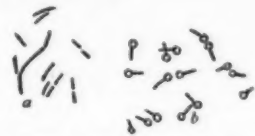


FIG. 13.—TETANUS BACILLI (Kitasato).

a, Sporeless bacilli; b, bacilli, each bearing a spore at its extremity, giving rise to club-shaped forms.

I have not hesitated to bring before you these illustrations, although at first sight they may appear foreign to the subject of my lectures, because I am convinced that it is of the utmost importance that those who are engaged in one department of bacteriology, e. g., in that which deals with fermentation phenomena, should constantly bear in mind the methods which have been found useful and the discoveries which have been made in other departments of the same science.



FIG. 14.—STREPTOCOCCUS OF ERYSIPELAS.



FIG. 15.—SPIRILLA OF ASIATIC CHOLERA. (Commonly known as "Comma Bacillus" of Koch.)



FIG. 16.—TYPHOID BACILLI (After Migula).

In conclusion, I would draw your attention to Figs. 14, 15, and 16, representing some of the best known pathogenic forms of micro-organisms.

OLEOMARGARIN.*

By Prof. G. C. CALDWELL, Cornell University, Ithaca, N. Y.

ONE of the most interesting groups of chemical compounds, and one of the most important in the arts, is the fatty acid series, so called because many of its members are obtained from fats. These acids, twenty in number, are constructed on the same plan, all of them containing two atoms of oxygen and each differing from its predecessor by CH₂, or twice or three times that; all of them have twice as many atoms of hydrogen as of carbon. If we compare acids that are contiguous to one another in the series, we find such close resemblance between them in properties that it is often very difficult to separate them completely from one another by either physical or chemical methods; but as the composition of these acids gradually changes with each increment of CH₂, the properties change also, so that comparing acids widely apart in the series we find very different properties. Formic acid, HC·HO₂, and acetic acid, HC₂H₃O₂, are easily soluble in water, very sour to the taste, quite corrosive on the skin when very concentrated and convertible into vapor without decomposition, so that they can be distilled. Palmitic and stearic acids, HC₁₅H₃₁O₂ and HC₁₇H₃₃O₂, also closely resemble each other, but differ strikingly from formic and acetic acids. They are quite insoluble in water, have no sour taste, cannot be distilled without decomposition and have no action on the skin, no matter how concentrated they may be.

Out of this series of acids, I select six as possessing special interest in connection with the subject upon which I have chosen to speak to you this evening. Four of these, butyric, caproic, caprylic and capric, are near together in one part of the series; and two, palmitic and stearic, are near together in another part.

Intimately associated with both of these groups is an acid of another series, oleic acid. As is known to all chemists, when any natural fat or fatty oil is heated with soda or potash, and this product is heated with a strong acid, a mixture of fatty acids is obtained, very rarely, if at all, any one fatty acid; glycerine is produced in the same operation. Corresponding to each fatty acid is a body called a glyceride; and it is the mixture of these glycerides that constitutes the original fat from which the mixture of fatty acids is produced. The glyceride of butyric acid is called butyrin; of caproic acid, caproin; of palmitic acid, palmitin, and so on.

Nearly all the ordinary natural fats and fatty oils consist essentially of three glycerides, palmitin, stearin and olein. The differences in odor and taste by which they are distinguishable from one another are due to minute quantities of other substances which they contain, and which are also associated with them in their natural or in their prepared condition. Castor oil, olive oil, tallow and lard are unmistakably different to our senses of taste and smell, but all of them alike consist essentially of palmitin, stearin and olein, this mixture being scented and flavored by the foreign substances just mentioned.

There is an important difference between the fat in milk and some other fats, on the one hand, and the fat of tallow, lard and palm nut oil on the other hand;

* A lecture delivered before the Franklin Institute, January 18, 1892—From the Journal.

a distinction all the more interesting, since it exists between the fat that is deposited on the carcass and that which is secreted in the milk of the same animal. Butter and tallow are mostly but mixtures of olein, palmitin and stearin, the same three glycerides that are so widely distributed in the fats everywhere; but butter fat contains, besides, the four other glycerides, butyric, caproin, caprylin and caprin; but since even these glycerides when purified are as tasteless and odorless as any of the others, none of the odor or flavor of butter can be credited to them.

This being the case, then, it is only natural that the attempt should be made to give a butter flavor and aroma to the more abundant and much cheaper fats of the animal carcass; it is only a question of transferring the carcass fat into one of the same consistency as that of butter at ordinary temperatures, removing its characteristic flavor, and substituting therefor the butter flavor. The first change is easy enough, consisting as it does simply in taking out a certain proportion of the less fusible stearin and palmitin, so as to leave a residue with a larger proportion of olein, and therefore softer at common temperatures, as butter is softer than tallow; since this odor and flavor are largely due to soluble and volatile foreign substances, steaming and washing the fat will leave a sufficiently odorless and tasteless product as a basis for receiving the desired butter flavor. It is plain that the available quantity of this product from the carcass fat is much larger than the available quantity of the material like which it is to be flavored, the butter fat of milk. How then shall this flavor be imparted?

We know quite well that when it comes to giving the flavor of lemon, strawberry or raspberry to ice cream or cake, not even the shadow of the fruit need be cast over the material to be thus flavored; much less need any of its substance be incorporated with the cream or dough; a chemist in his laboratory can manufacture at least many of these flavoring essences more cheaply than they can be made from the fruits. But I am not aware that any essence of cow's butter has ever yet been prepared. A clean mixture of olein, stearin and palmitin, no matter how carefully the proportions of these three ingredients might be adjusted to secure the right consistency, no matter how deftly colored, would never pass for butter, even with the least fastidious. Therefore, the amount of salable artificial butter that can be made from this oleomargarin is limited by the degree of thinness with which real butter fat with its butter flavor can be distributed through it, and produce a resemblance to butter.

Just here a few words in explanation of the terms oleomargarin, margarin and butterin may well be given. In the list of fatty acids margaric acid comes between palmitic and stearic. Originally it was believed that the three glycerides, palmitin, margarin and stearin, together, made up the less fusible part of all fats; and that a mixture of the four fatty acids, oleic, palmitic, margaric and stearic, was obtained when these fats were saponified and the soap was decomposed by a strong acid. In fact, the three acids, palmitic, margaric, and stearic, were apparently separated from one another out of this mixture of acids by repeated recrystallization; the supposed margaric acid thus obtained refused to change any further by continued treatment of the same kind as that by which it was made, and as its composition, melting point, specific gravity and solubility were such as might be expected of any acid standing midway between palmitic and stearic acids, no one doubted the existence of this glyceride in these fats. Heintz, in 1852, declared that this was all a mistake, that this supposed margaric acid was only a mixture of palmitic and stearic acids, and that every specimen of so-called margaric acid prepared from fats could be resolved by his method of fractional precipitation into palmitic and stearic acids. Five years later he prepared the real margaric acid in a pure state, by chemical action on spermaceti, possessing all the properties that margaric acid should possess, including, in addition to what the old acid did not possess, a persistent obstinacy against being split up into palmitic and stearic acids.

But while margarin does not occur in natural fats, its name still remains associated with the less fusible part of animal and vegetable fats, although this mixture is one of palmitin and stearin only; and since olein from the other series of glycerides is always associated with palmitin and stearin in these fats, we have the familiar name oleomargarin for this manufactured product; the same name could just as appropriately be given to many other fats, and just as incorrectly also; but it has come to be a trade name, the meaning of which is understood by everybody. First, when this oleomargarin, or oleo oil as it is sometimes called, is churned with milk and water, we have the real artificial butter, or butterin.

The name of a Frenchman, Hyppolyte Mège, or Mège-Mouries, is most prominently associated with the early history of this new food product. The statement is generally made that he was requested by the French government, and one writer says by Napoleon III. himself, to make the experiments that led to his invention, for the express purpose of discovering a substitute for butter that would be cheap enough to come within the reach of the poorer classes and would also keep better than butter, and thus be adapted for use in the navy. In 1873, he took out his first patent in this country, which was essentially as follows: The crude fat was first disintegrated between rollers, then heated about 103° F., to separate it from the tissues, or to render it, technically speaking; during this rendering he added two liters of gastric juice for every 100 pounds of the fat; this gastric juice was obtained by macerating half of the stomach of a pig or a sheep with three liters of water containing thirty grammes of diacetic phosphate; salt was also added to facilitate the separation from the tissue; the fat was then kept for a long time at a temperature of about 98° F., to allow the less fusible glycerides to crystallize out partially, after which they were separated from the more fusible part by heavy pressure in cloth bags; that which remained in the bags was called the stearin and that which passed through the oleomargarin. This the patentee says is a fatty matter with a very good taste that may replace butter as used in the kitchen.

To make a more perfect butter, he mixes this first product, as it comes from the press, very thoroughly with ten per cent. of its weight of milk and cream, at a temperature of about 71° F. The mixture is cooled

and worked between rollers to give it the consistency of natural butter. He has also found it expedient to mix with the milk or cream one-fiftieth of its weight of mammary tissue from the udder of a cow, chopped very fine, one one-hundredth of sodium carbonate, and some coloring material.

This patent was followed by nearly fifty others, relating to the manufacture of oleomargarin, or some similar product, or artificial butter. Some of the new names introduced are curious: such as butteroid, oleoid, creamine, oxyline; this last name is very suggestive of the manufacture of the substance from oxen. There are curious processes too in some of these patents as well as names; in one, the use of salt, saltpeter, borax, salicylic acid and benzoic acid is covered; in another, that of swine fat, cotton seed oil, slippery elm bark, and beef stearin; in another, nitric acid; in another, lard, beef suet, butter, glycerin, salt, water, and coloring matter.

After all this effort of the inventors for something new in materials used or methods of manipulation followed, the process has simmered down to a very simple one, which is in reality only a part, and almost unchanged, of Mège's original process. The fat, said to be only the caul fat, and possibly so in all the large manufacturing, is washed in cold water, surrounded with ice till the animal heat is removed, cut up fine, heated to from 120° to 150° F., allowed to stand till the fat is separated clearly from the tissue, then kept in wooden tanks for from twenty-four to thirty-six hours in a warm room, at such a temperature as will favor the crystallizing out of the largest part of the stearin, together with a little of the palmitin; then, in hydraulic presses in the same room, the solid fat is separated from the liquid, or the "oleo oil." Another product is prepared from lard in a similar manner, except that no stearin is removed from it, and this goes by the technical name of "neutral." From this oleo oil and neutral the oleomargarin and butterin are made, more oleo being put in if the product is to go to a cold climate, more neutral if to a warm one; the proper mixture of the two is churned in a steam-jacketed vessel, with about forty-eight gallons of milk to every 2,000 pounds of fat; it is stated that cream is sometimes used in the place of milk; butter coloring or annatto is used unless forbidden by law. The churned product is suddenly cooled by allowing it to run out on to ice or cold water, then washed, salted and worked as butter usually is.

The use of lard is comparatively recent, and it is interesting to notice that the first manufacturers of artificial butter were very indignant when it was attempted in the West to palm off a product from lard as oleomargarin; they used about the same contemptuous expressions concerning this as the dairymen now use so freely when speaking of the oleomargarin. Such is the substance of the simple process for the manufacture of artificial butter in its various forms.

As to the quality of the product. In the first place, it keeps well if made from clean materials; because, as is claimed, of the absence of the lower glycerides of the series, especially butyric, and also, as I think may be safely said, because more free from nitrogenous matters, in which the tendency to putrefy is very strong. A second important quality is such close resemblance to genuine butter of fair quality that often only experts can distinguish one from the other. Amusing stories are told, illustrative of this close resemblance, many of them, perhaps, only partially true, yet all of them possible.

It is claimed that samples of artificial butter have carried off prizes at fairs for first-class genuine butter. One manufacturer certified before a legislative committee in my own State that he had in many instances put the artificial product before his friends by the side of dollar-a-pound butter or fifty-cent butter, and they were unable to detect the difference. I myself gave to a friend keeping an excellent boarding table a small box of the artificial butter that I carried away with me from one of the manufacturing in New York. The usual butter supply of this table was always unusually fine and the boarders were correspondingly critical; but they did not notice anything unusual in what was on the table at that meal. The story is told of a board of managers of the agricultural society of this State, that a print and a roll of oleomargarin butter were sent to them, with the inquiry: "Which is butter?" At first they pronounced the roll to be butter; then they said the print was butter; then they tried some one of the simple tests that have been put forth from time to time for detecting oleomargarin, but which are usually worthless, and they finally concluded that both the print and the roll were oleomargarin, as they really were; but they closed their report with this question: "Are we right?"

But by far the most important question concerning the oleomargarin as food is that of its wholesomeness, as compared with butter. The answer to this question turns on two points.

(1) The quality of the materials used in its manufacture.

(2) Its digestibility when properly made.

It may be safely said that no other food product has been so much discussed in respect to its healthfulness.

In the first place, what bearing has the quality of the materials used in the manufacture of oleomargarin on its wholesomeness? Concerning this, most damaging statements have been made; especially was this the case at the very beginning of the oleomargarin war. Many were doubtless suggested by some of the patents that were issued at this time; the purpose of some of these patents was openly stated to be to make foul fats clean, at least so far as taste and odor might serve to detect foulness. Here are a few of these statements, made or indorsed even in legislative halls. "All kinds of filthy fats are used." "Animals dying from all kinds of diseases are utilized." "Artificial butter is the compound of diseased hogs and dead dogs. It is so manufactured that it is a poison, for it has collected in its germs of all the diseases that infect animals." "The city scavenger butters your bread and his reeking hand decks your table." "St. Louis manufactures lardine, a compound of hog fat and decayed vegetable matter; horses dying with glanders and pneumonia and dogs dying with rabies are carted to the boiling establishment where the fat is extracted and shipped away. What assurance have we that it does not find its way to the butterin factory? None." "This article of the

slaughter pen and apothecary shop, the product from a charnel house run through a chemical laboratory, carrier of death and the grave." "A compounded article, mainly composed of ingredients that are not food products, or those of an inferior, deleterious, and nauseating kind—refuse and offal which have served their purposes, and been relegated by the decent sense of mankind to the dung heap." The names of congressmen making these statements are given in the document from which these extracts were made. A prominent agricultural writer of my own State wrote that "There is nothing in the fat line so filthy and disgusting that it cannot be deodorized and incorporated into the stuff." A Boston butter dealer stated, to the congressional committee, that "Every conceivable grease of the filthiest kind in our country is manufactured into imitation butter, and sold to consumers."

We all know that a good many things are said for effect by our legislators as well as by others that will not bear close examination into their correctness. If even the half of these statements were true, then certainly a committee of the New York Legislature, intent on making in its report the very most possible showing against oleomargarin, in support of a very stringent and prohibitory law, could have obtained similar statements from some of the numerous witnesses cited before it; but a careful examination of the whole printed report of 276 pages reveals no worse assertion than this, that not merely the caul fat, or that on the membrane investing the viscera, is used, but also that on the intestines themselves; and this witness affirms that this fat was in the vats mixed up with some of the excrementitious matters naturally associated with fat in that condition; but in the same report the manager of this factory testifies that not all of the fat received at the establishment is used for oleo, since they manufacture tallow also; and that but a very little of the intestines remains attached to that part of the fat used for oleo; the first witness did not testify that he actually saw the foul fat that he described worked into the oleo oil. No sound proof is anywhere given that such extravagant statements as those which I have quoted are founded on facts, or were anything more than conjectures or guesses.

But oleomargarin has been no less bitterly and extravagantly attacked on another line, namely, with reference to what has been found in it especially by microscopic examinations. Prof. Michels, of New York, in 1878, stated that he had found cells of a suspicious character, and fragments of muscle and tissue in some of the samples that he examined; these, however, he acknowledged came from the chopped stomach then used according to the original Mège patent; but he affirmed that trichina might get into the butter in this way, and that the heat to which the fat was subjected in the course of the rendering and the crystallization would not be high enough to kill them.

In 1880, a Professor Piper gave in a Chicago daily paper some startling drawings of what he had seen in some samples of oleomargarin butter, under the microscope—shreds of animal tissues, spores, and a form often found by him in foul water; and in another paper he gave figures of actual tape-worm eggs, and by the side of these very similar forms from oleomargarin. Passing on to a later date, when the addition of chopped stomachs and mammary glands had been entirely given up, very little is reported of observations of this kind. A Professor Nachtrieb is quoted as finding in a sample of butterin parasites that are present in the rectum of swine and in the evacuations of patients suffering from chronic diarrhea; but without further knowledge as to the reliability of this professor as a microscopist, one should give little weight to such a startling statement. Two samples of artificial butter out of ten were reported by an official of the Department of Agriculture as being full of fungi and their spores; but as all of these were also reported as being in a bad condition even for samples of butterin, such an observation furnishes no reliable evidence as to the usual quality of the substance; further, the reputation of this observer was not of the best.

Before leaving this part of my subject, I cannot forbear quoting one or two more of those wonderful Congressional statements: "The best samples had many kinds of living organisms in them, with masses of dead mould, bits of cellulose, various colored particles, shreds of hair, bristles, etc., while other samples teemed with life; doubtful portions of worms were also noticed." Again, "There were in every specimen more or less foreign substances, a variety of vegetable and animal life. Among these were corpuscles from a cockroach, small bits of claws, the blood corpuscles of sheep, the egg of a tape-worm, a portion of a worm, a dead hydra-iridis, portions of muscular fiber, fatty cells and eggs from some small parasite;" and all this, I am ashamed to say, said by a member from my own State. You will notice that these two statements begin, the one with the words "the best specimens," the other with "every specimen." That any such observations could have been made on the best samples of oleomargarin, or even on all samples collected at any given time, is, I am safe in affirming, in the highest degree improbable, not to say entirely out of the question, even at the time when chopped pigs' stomachs and mammary glands were worked into the product; and that they could have been made, at or about the time when these statements were made, I consider quite impossible, such addition having been then long given up.

The answer to the question as to the wholesomeness of oleomargarin must then be sought on other lines of inquiry. Fats as such are not unwholesome when not eaten in excess. We need then only to consider whether one fat, clean oleomargarin, is as wholesome as another fat, butter, and we will consider first their comparative digestibility. By far the best statement of the case in this respect, it may be said, against oleomargarin, is to be found in the second annual report of the New York State Dairy Commissioner for the year 1885, by Dr. R. D. Clark, chemist of the commissioner. Many authorities are there quoted to the effect that butter is more digestible and wholesome than lard or other natural fats; and this difference is attributed to the more complex composition of the former, and especially to its butyric. The effect of this substance is supposed to be due to the ease with which it breaks up into fatty acid and glycerin.

Saponification is thus facilitated, and the soap formed in its turn favors the digestion of the other fats of the butter. The digestion of the fats consists partly of this saponification and partly of their conversion into an emulsion. Dr. Clark performed some emulsifying experiments with different fats and the pancreatic juice, which is the chief emulsifying agent of the digestive liquids. Next to cod liver oil, butter gave the finest emulsion in twelve hours; while oleomargarin still had many large globules left unchanged. It is fair to suppose that the finer the emulsion and the more quickly it is made, the more readily the fat will be resorbed, assimilated and taken into the circulation, and that easy saponification will also favor digestion. Dr. Clark also proved that while butter melts to a clear limpid liquid in thirty-five minutes, at 100° F., the oleomargarin was but slightly changed; even after five hours the latter was still only in a semi-solid condition; this property of oleo butter is certainly not favorable to its digestion. Thus a very good case is made out by Dr. Clark, to the effect that oleomargarin is in all probability somewhat less digestible than butter. This view is supported by the results obtained by A. Mayer in a comparative test of the proportion of fat assimilated by a man and a boy, using butter of the ordinary kind for three days and then oleomargarin for the same period; the difference was slightly in favor of the butter; but so slight that the writer considered that it might be neglected, except in the case of invalids or very young children. In France, the first opinion of medical men in 1872 as to the digestibility of oleomargarin was not unfavorable, but eight years later it was pronounced against in the Paris Academy of Medicine, the statement being that it could not replace good butter, because on account of the higher percentage of fatty acids it emulsified less easily and was therefore less easily absorbed; but I can find no account of any actual digesting experiments in support of this conclusion, like those of Mayer's just quoted, and which are of much more account than any theorizing.

The question of the occurrence of germs of disease in oleomargarin is of such great importance that it needs some further consideration. The possibility of their occurrence there cannot be denied; and it must be allowed that the heat applied in any stage of the manufacture of the oleomargarin is not sufficient to kill these germs if present.

Dr. Clark gives as diseases that may be communicated from animals to man, consumption, anthrax, trichinosis, tape worm, glanders, foot and mouth disease, cow pox, hydrophobia, etc.; the etc. implies that there are still others; but the list is fearful enough as it is. Now, what evidence is there that any of these disease germs are in oleomargarin? Granted that they may be there; but have they ever been found there by reliable observers? Any evidence of this, sound and satisfactory, would be the most damaging that could possibly be produced against this food product. The observations quoted in an earlier part of the lecture as made by Piper and Nachtrieb, utterly lack confirmation by others; no similar observations have ever been reported since. Dr. Clark, in his summary, does not even refer to them. It may therefore safely be affirmed that there is no evidence whatever that in the oleomargarin of later years, from 1885 up to the present time, any germs of disease exist.

But good evidence of the communication of any of these diseases to man by the use of oleomargarin would be no less fatal to this food product. Members of Congress assert that its consumption "Leads to insanity, Bright's disease, and ailments that undermine the strongest constitution;" that "It is freighted with disease, freighted with death; that it spreads disease and death throughout the country." Dr. Clark, above quoted, in response to the demand for cases of illness caused by oleomargarin, can only say that "We have seen many cases of sickness, much of it dyspepsia, during the period in which ~~boas~~ butter was so freely sold without restriction, for which we have been unable to assign any cause; this cause may have been the use of artificial butter; but the deceptive manner in which it has been handled has prevented physicians from ascertaining its effects; consequently we must judge by its qualities." This is a confession that up to that time, 1886, and only shortly after a time when it was claimed that 30,000,000 pounds per annum were made, and mostly used in New York and England, no case of disease nor any general specific form of disease could be pointed out as due even in the most indirect manner to the use of this food product. A widely quoted statement to the effect that the physicians of Chicago attributed the epidemic of winter cholera to the extended use of butter in that city, into the composition of which lard entered largely, may be taken for what it is worth, as an exception to this statement of mine. I cannot verify or dispute it.

The chairman of the New York legislative committee from which emanated the present stringent prohibitory law of that State, in his report on the committee's investigations, could only say in reference to the wholesomeness of oleomargarin, that sickness of various kinds may result from its use, communicated by the germs of disease that have been found in samples of it; but nowhere in the report of the committee is any evidence adduced of the occurrence of these germs. Even a single case of disease unmistakably attributable to oleomargarin would have been invaluable in promoting the passage of the desired law, but he could not produce it; and in another place in the report he frankly allows that "There is evidence on both sides as to its wholesomeness. Time and further investigation may be needed in order to establish a satisfactory solution of the question of trichina, animalcules, or germs of disease in raw animal fats and their tissues. Meanwhile, however, there is well grounded suspicion of them." Time there has been, years of it, since that report was made public. The prohibitory law was passed, but no further investigation has been reported on the trichina and germ question, and the danger of disease from this cause must be regarded as unproved.

An interesting incident bearing on this matter has very recently come to my knowledge. At an asylum for blind children, in Louisville, Ky., where good butter had been supplied, good oleomargarin butter was substituted. No notice was given of the change, and even if the appearance of the substitute would have betrayed it, the blind children could not have seen it. There was no evidence that they were in any way con-

scious of the change; but it was observed that they gradually ate less and less of the new butter, and finally they declined it altogether. No bad effect on their health could be discerned. They made no complaint in answer to the inquiry as to the reason for not eating the butter other than that they did not care for it. It was as if it did not adapt itself to any need of the system. This certainly must be allowed to count against the complete fitness of oleomargarin as a substitute for butter.

(To be continued.)

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